

## Understanding the Role of Achievements in Game-Based Learning

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### Abstract

*The objective of the current research was to examine whether one potentially effective gaming strategy—achievements—has a positive impact on learning in a game-based environment. An achievement in a video game is a reward or recognition earned by players for an in-game accomplishment. This paper describes a series of studies to evaluate the effects of achievement types on learning in a game designed to teach about health resources. The Game “Phone Dash” was used as the testbed for the following studies. The following questionnaires were utilized in this study: Video Game Self-Efficacy Scale (VGSES) questionnaire, Relevance and Usefulness questionnaire, Game Engagement Questionnaire (GEQ), and the Intrinsic Motivation Inventory (IMI). Four studies were conducted. Results indicated that while in unison, the achievements were not as potent in motivating performance, certainly when combined they produced measurable changes in behavior. The four studies described in this paper provide important information regarding the optimal design of achievements in game-based health education. Developers of future game-based learning can use this information to enhance the potential effectiveness of their products.*

**Keywords:** *Achievements, Learning, Design*

### 1. Introduction

There has been growing interest in using video games as teaching tools. Indeed, there is evidence that game-based training can achieve positive learning outcomes. However, without further research, it is impossible to determine exactly why such games are effective. Moreover, we believe that it will be more fruitful in the long run to investigate the impact of game features on learning. Our reasoning is that there are likely effective and ineffective instructional strategies embedded in any game, so investigating whether the entire game is an effective teaching tool is not very informative. Instead, we advocate a more detailed strategy that reduces game-based formats into more precise strategies that can then be manipulated systematically and associated with learning outcomes. Hence, the purpose of the current research was to examine whether one potentially effective gaming strategy—achievements—has a positive impact on learning in a game-based environment.

An achievement in a video game is a reward or recognition earned by players for an in-game accomplishment. Achievements are often used in commercial video games to extend playtime by adding additional goals or by serving as extrinsic motivators added to those incumbent in the game. The concept of achievements has been in video games since Space Invaders, which allowed players to earn a "hi-score" and post their initials for other players to see. The entertainment gaming industry's use of achievements today is pervasive. In fact, a game cannot be on Xbox Live or the PlayStation Network (Sony), two popular gaming consoles, without having achievements in it.



## 2. Background

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In contrast to entertainment games, the serious games industry, which creates games for the purpose of teaching (among other things), has been much slower in their adoption of achievement systems. However, this form of feedback and reward could be beneficial to an industry that often struggles with the challenge of making games that are both entertaining and educational. For example, to the extent that time-on-task contributes to the effectiveness of a serious game, the use of achievements to increase playtime could very well be beneficial to learning [1]. Indeed, achievements can add incentive for performing a task to a particular standard and/or simply increase a learner's time on a given task trying to complete it. In fact, both increased effort and increased time on task seem to be the most promising benefits of including achievements in serious games, as both have been shown to increase the learning value of an experience [2]. However, there is no empirical evidence to suggest that achievements are actually effective in creating these outcomes. Because a serious game's entertainment value is subordinate to its instructional value, the effect that achievements have on learning should be investigated before they are put into use. This paper describes a series of studies to evaluate the effects of achievement types on learning in a game designed to teach about health resources.

### 2.1 Expected vs. Unexpected Achievements

Players either know what achievements can be earned before they play a game or they discover them unexpectedly during play. Expected achievements allow players to set goals by deciding which achievements they would like to try to earn. Unexpected achievements are unknown to the player until they earn or "unlock" them. Players are typically aware that they exist in the game but are never told how specifically to earn them. There are benefits and detriments to both expected and unexpected achievements. Regarding expected achievements, these can provide the opportunity to create a *schema*, or mental model, about the game about to be played, which has been shown to be beneficial for learners. For example, the use of schemas in training has been shown to improve learner performance in mathematics [3], reading comprehension [4], and word problem solving [5]. To facilitate this, achievement descriptions should be worded to accurately represent the framework and goals of the game that is about to be played.

Although not as popular as expected achievements, there are benefits to having unexpected achievements in games. Unexpected achievements should be randomly inserted throughout games in order to give the players incentive to experiment and test boundaries outside of normal play. Fostering creative play in order to "unlock" rewards could increase playtime.

### 2.2 Timing of Achievement Delivery

Players can be alerted about an earned achievement either during play as the event takes place or after play in a review of their performance. Achievement alerts that happen as soon as they are earned are a form of immediate feedback. Some studies have shown immediate feedback produces superior learning outcomes [6] and increased efficiency [7]. However immediate feedback may not always be appropriate for more advanced learners as it may impede their ability to critically evaluate their own performance [8]. Immediate feedback should be given to novice learners and slowly decreased as they reach greater skill levels [9].

For achievement alerts that occur during play, whether they are disruptive or non-disruptive is an important design consideration. There are several benefits associated with a flow state including increased motivation [10], control [11], and enjoyment [12]. Achievement alerts that occur during play but are disruptive can break flow. "Flow denotes the holistic sensation present when we act with total involvement" [13]. An achievement earned during play would almost certainly break a player's flow when the notification is given. The notification would be unexpected and would make questions like "am I doing well?" or "what am I doing here?" or "should I be doing this?" However an achievement that is expected and ideally being strived for by the player would narrow focus and enhance flow up until the moment of earning it. Alternatively, some games use achievement notification systems that alert the player after game play. This type of delayed feedback has been shown to improve learning and (especially) retention under certain conditions [14].

### 2.3 Incremental and Meta achievements

Incremental achievements are awarded in a series for completing the same task but scaling levels of difficulty. Examples of incremental achievements are catching 25, 50, 100, 250, 500, and 1000 fish in World of Warcraft, earning different colored ribbons in Farmville, and the star rating in Angry Birds. Meta achievements are earned for completing a series of achievements that are for different tasks, for instance earning the title of "Salty" by completing all fishing related achievements in World of Warcraft.

Incremental achievements can be used as a type of scaffolding in order to break up a player's progress into specific and moderately difficult goals that will lead to better performance [15]. The increasing levels of difficulty in incremental achievements, when paired with other scaffolding techniques like task sequencing [16] and chunking of information [17], can facilitate the expansion of the player's zone of proximal development as their skill level increases over many sessions of game play [18]. These types of achievements are grouped together into a schema so it is apparent to the learner that they are related and if completed are a model for success. Incremental and meta- achievements that can only be completed over extended periods of time are similar to long-term incentive programs which have been shown to return greater performance gains when compared to shorter-term programs [19]. Incremental achievements, if designed properly, could work like scaffolded learning objectives that increase performance and set the bar higher and higher. Cross-game meta- achievements will signify a history of play and a breadth of experience that other players will recognize. However, these types of achievements have a potential downside. A player's sense of autonomy could be decreased if they are lacking self-direction and the achievements feel like a carrot on a stick [20]. If the achievements are too numerous and do not challenge the player their performance could be impeded [21].

### 2.4 Goal Orientation

Goal orientation must be considered when designing achievements because a player's orientation might alter how they experience a game. Elliott and Dweck [22] and Ames and Archer [23] described the two types of goal orientation as either *performance orientation* or *learning orientation*. Individuals in a performance oriented state "seek to gain favorable judgments of their competence or avoid negative judgments" while learning oriented "individuals seek to increase their competence" [23]

Players high in performance orientation will take fewer risks and experience less of whatever they are participating in because their fear of failure makes them avoid experimentation that could affect their "score"[24]. They would rather choose tasks that enable them to demonstrate their competence at the expense of learning something new [25]. Players who have a learning goal orientation will accept errors and seek challenging tasks that provide them the opportunity to develop their competencies [25]. Not only attitudes and motivation are affected by goal orientation; in some studies, performance was also directly tied to a participant's orientation. For example, Winters and Latham [26] found that trainees who were given performance oriented goals performed better on simple tasks, while trainees given learning oriented goals performed better on complex tasks. In addition to the performance differences trainees who were given learning goals also had higher self-efficacy and utilized more effective task strategies.

### 2.5 Hypotheses

Given all that has been said about achievements and how they can be designed to maximize learning in serious games, we sought to empirically evaluate the following hypotheses:

H1: Players who have expected achievements will perform better than those who have unexpected achievements

H2: Players who have incremental achievements will perform better than those who have non-incremental achievements

H3: Players who have incremental achievements will spend more time playing than those who have non-incremental achievements

H4: Players who receive notifications after play will perform better than those who receive notifications during play

H5: Players who receive notifications after play will have more enjoyment than those who receive notifications during play

### **3. Materials and Methods**

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#### **3.1 Measures**

The following measures were used in each of the studies:

Video Game Self-Efficacy:

The Video Game Self-Efficacy Scale (VGSES) questionnaire consisting of 10 items for use with assessing perceived self-efficacy when playing video games [27].

Game Engagement Questionnaire:

The Game Engagement Questionnaire (GEQ) measures engagement during video game play [28]. The questionnaire consists of 19 items scored on a Likert scale measuring specifically absorption, flow, presence, and immersion. Cronbach's alpha for the current 19-item version of the GEQ was .85.

Intrinsic Motivation Inventory (IMI):

The Intrinsic Motivation Inventory (IMI) utilizes several sub-scales that relate to user experience during a targeted activity. For this study the Interest/Enjoyment sub-scale that contains 7 questions and the Effort/Importance sub-scale that contains 5 questions will be used. The interest/enjoyment sub-scale is associated with self-reported intrinsic motivation [29].

#### **3.2 Testbed**

The Game "Phone Dash" was used as the testbed for the following studies. Phone Dash was developed to assist students in learning about the many health resources available to them on a college campus. Players are placed in the role of a phone operator who must route calls about various health concerns to the appropriate campus agency. The game is similar to the popular game "Diner Dash." The game requires the player to respond to simulated phone calls. The player must match the caller's request with the appropriate resource. The number of calls and possible resources increases with each level. "Phone Dash was a knowledge assessment and time management game where players operated a call center. Players had to direct the callers to the proper resource depending on the information obtained from their phone call. Phones would only ring a limited number of times before the player had to answer or put them on hold. Callers would only remain on hold for a short period of time before hanging up. The number of telephones the player had to answer increased with each round. The game interface is illustrated in Figure 1.



**Figure 1:** Screen shot of the Phone Dash game.

Phone Dash contained the following achievements:

First call - Answer a call correctly

Speedy - Correctly complete 5 calls in 15 second

Flawless victory - Earned for having an error free round

No time for delay - Complete and entire round without putting a call on hold

Streaker - Get a correct streak of 8

Super star - Get 3 stars on each level

Practice makes perfect - Replay a level from the final review screen and earn a better score than your first attempt."

### 3.3 Study1 Methodology (Expectation Effects)

30 participants were randomly assigned to each of three conditions: no achievement, expected achievement, or unexpected achievement. In the unexpected achievement condition, achievements were provided in the game, but the players did not know that they existed or how they were earned. In the expected achievements condition, players were informed what the achievements were and how to earn them prior to play. The control condition provided no achievements. Participants were briefed about the study and provided with the waiver of documented informed consent. Participants were then asked to complete a demographics form and to complete the Intrinsic Motivation Inventory (IMI) questionnaire. A pretest for knowledge of game content was also given. The participants played the game Phone Dash (with achievements) for as long as they liked, before a posttest was given. The amount of time they played was measured. Participants were given a posttest for the game content that was equivalent to, but

containing different content from, the pretest. Participants were then asked to complete the Game Engagement, and Intrinsic Motivation Inventory (IMI) questionnaires. Participants played three increasingly difficult levels of the game.

### 3.4 Study 2 Methodology (Incremental Effects)

Study 2 was designed to evaluate the effects of *incremental achievements*. The methodology was identical to Study 1, except that one group (n=15) was assigned to an incremental achievement condition and a second group (n = 15) was assigned to a non-incremental achievement condition. Incremental achievements consisted of a three star rating. Each star represented a different level of performance on the learning task. Non-incremental achievements were given for a single accomplishment at the two star level of difficulty.

### 3.5 Study 3 Methodology (Timing Effects)

The methodology for Study 3 was identical to Study 1, except that one group (n = 15) was assigned to a during-performance condition and another group (n = 15) was assigned to an after performance condition. During play notifications took the form of an unobtrusive pop-up. After play notifications were given out in a review screen after the game has been completed.

### 3.6 Study 4 Methodology (Combined Achievement Effects)

The methodology for Study 4 was identical to Study 1, except that one group (n = 15) was assigned to a game condition in which one group was assigned to a “combined” condition where each of the elements predicted to increase performance was included (e.g., expected, incremental, and post-performance feedback). The goal of this manipulation was to see if the combined effect of theoretically-beneficial achievement design was greater than the individual design elements.

## 4. Results

### 4.1 “Expectancy” Study Results

Hypothesis 1 predicted that players who had expected achievements would perform better than players who had unexpected achievements. Performance was assessed by number of replays, achievements earned, calls answered, and pretest/posttest scores. A 3 X 2 mixed ANOVA indicated the following: Test scores improved across test administrations, regardless of condition  $F(2,76) = 21.46, p < .05$ . However, there was no interaction between test administration and condition ( $F(2, 76) = .51, p = n.s.$ ). Also, there was no significant difference in the number of achievements earned as a function of condition ( $F(2,92) = 1.47, p = n.s.$ ). Across test administrations, players with expected achievements answered significantly more calls than the control. Players with unexpected achievements did not perform better than the control group. The means and standard deviations for each group are presented in Table 1.

**Table 1.** Means and Standard Deviations for the “expectancy” study

	Performance	
	M	SD
Expected	7.76	.214
Unexpected	8.18	.212

### 4.2 “Incremental” Study Results

The data were analyzed in a manner identical to Study 1. A 3 X 2 mixed ANOVA indicated the following: No significant difference between the two conditions in the number of achievements earned. Test scores improved from pre-test to post-test ( $F(1,18) = 26.00, p < .01; M = 8.1$  and  $9.6$ , respectively). However, there was no interaction between condition and trial ( $F(1, 18) = .62, p = n.s.$ ). Players answered

more calls from level 1 to level 2 ( $F(1,18) = 13.1, p < .05; M = 7.1$  and  $9.2$  respectively), but there was no interaction with condition ( $F(1,18) = .16, p = n.s.$ ). The means and standard deviations are presented in Table 2.

**Table 2.** Means and Standard Deviations for the “Incremental” study.

	Performance	
	<i>M</i>	<i>SD</i>
Incremental	8.04	.332
Non-Incremental	8.17	.332

#### 4.3 “Timing” Study Results

The data were analyzed in a manner identical to Study 1. A 3 X 2 mixed ANOVA indicated the following: No significant difference between the two groups in the number of achievements earned. Participants, regardless of condition, improved in the test scores from pre-test to post-test ( $F(1,19) = 41.997, p < .001, \eta^2 = .689$ ). However, there was no difference as a function of condition ( $F(1,19) = .208, p < .653, \eta^2 = .011$ ). Regardless of condition, players answered more calls from pre-test to post-test ( $F(2,40) = 11.437, p < .001, \eta^2 = .364$ ). Players who received notifications during play showed a greater increase in calls than did the “after” group.  $F(2,40) = 3.698, p < .034, \eta^2 = .156$ . The means and standard deviations are shown in Table 3.

**Table 3.** Means and Standard Deviations for the “Timing” study

	Performance	
	<i>M</i>	<i>SD</i>
Notifications after play	4.20	.675
Notifications during play	4.30	.856

#### 4.4 “Combined” Study Results

The combined achievement trial players had significantly higher improvements in the pre to post test scores than the control group ( $F(1,45) = 9.73, p < .003, \eta^2 = .178$ ).

There was a significant difference between the combined achievement trial players ( $M=4.36, SD=0.9$ ) and the control group ( $M=3.73, SD=1.04$ ) in perceived relevance;  $t(46)=-2.04, p=.047$ . There was a significant difference between the combined achievement trial players ( $M=3.63, SD=0.83$ ) and the control group ( $M=2.92, SD=1.06$ ) in behavior intention;  $t(46)=-2.33, p=.024$ . The combined achievement trial players also had significantly higher improvements in intrinsic motivation than the control group ( $F(1,46) = 4.21, p < .046, \eta^2 = .084$ ). Means and Standard Deviations are presented in Table 4.

**Table 4.** Means and Standard Deviations for the “Combined” study

	Intrinsic Motivation	
	<i>M</i>	<i>SD</i>
Combined achievement	4.36	0.90
Control	3.73	1.04

## 5. Discussion

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The intent of this study was to measure the effect that different types of video game achievements have on player's learning, performance and attitudes. Improvements in performance were the predicted outcomes of using expected and incremental achievements, as well as notifications after play. Improvements in performance were also predicted for the "combined achievement." Enjoyment, another important consideration for video games, was expected to be affected by certain achievement design decisions (H3, H5). Incremental achievements causing extended playtimes and notifications after play encouraging flow states were both expected to improve enjoyment.

For Hypotheses 1, 2, and 4 the performance of all groups improved from pre-test to post-test. However, this improvement did not differ as a function of achievement condition. It was noted that the overall number of calls answered was significantly higher in the expected achievement condition, which may provide partial support for Hypothesis 1. This finding indicates that players increased their effort because they saw what achievements they could potentially earn. In contrast, players who had unexpected achievements did not put forth as much effort, resulting in fewer answered calls. However by levels 2 and 3, the expected and unexpected conditions became roughly the same in number of calls answered. A potential cause of this could be that after level 1, players in the unexpected group earned an achievement. Once players were aware that achievements could be earned by performing well and their level of effort would have increased.

Players receiving notification of an earned achievement during play had an increased number of calls answered when compared to those who received notification afterwards. Hypothesis 4 predicted that the opposite result would be observed due to the notifications during play being disruptive and breaking the player's flow state. The "during" play notification in this case, however, were implemented in such a way to not be disruptive. Without being disruptive they do not affect the player's flow and instead act as immediate feedback, which in turn increased their effort, leading to an increase in the number of calls answered. Immediate feedback, in this case, could have also increased efficiency (Schooler & Anderson, 1990). The enjoyment predicted by Hypothesis 5 showed a similar, contrary result, due to the non-disruptiveness of the "during notifications." The predicted difference in enjoyment would have been caused by the same anticipated break in flow. Because there was no break in flow players reported almost identical enjoyment between the two, with a slight advantage going to during notifications.

Hypothesis 3 predicted that players would spend more time playing if they had incremental achievements designed to increase overall playtime by providing "scaffolded" goals. However, there was no observed difference in playtime between incremental and non-incremental achievements. One explanation for this could be the time span that was used to evaluate playtime. Specifically, the evaluation was performed on what would be considered one play session. An additional measure that may have yielded better results could have been the option for players to return to the game at a later date. Incremental achievements may not have increased the length of time for a single play session, but they may increase the likelihood of returning for additional play sessions.

The results of the combined achievement were by far the most successful. In the combined trials, the achievements were incremental, expected, and notifications occurred after play. The design features used in the combined achievement seemed to have a more powerful effect in unison than when they were measured independently. The expected incremental stars may have made it apparent to the players that in order to achieve mastery at the game they would have to play the game frequently and seriously. This would account for the significant finding in the behavior intention measure. The expectation and anticipation caused by the expected incremental achievements may have been intimidating to players, which would explain the lower intrinsic motivation.

In conclusion, the four studies described in this paper provide important information regarding the optimal design of achievements in game-based health education. While in unison, the achievements were not as potent in motivating performance, certainly when combined they produced measurable changes in behavior. Developers of future game-based learning can use this information to enhance the potential effectiveness of their products.

## 6. Conclusions and future work

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The results of these studies demonstrate that the role of achievements in learning games may be more subtle, and more complicated, than originally thought. Simply adding individual types of achievements did not result in learning games. Only a combination of achievement elements resulted in a discernable effect of learning outcomes. However, these results should be evaluated with different types of games and different types of learners. It may be that the student population used here was simply not as motivated as learners might be in the workplace or schools.

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