"Gaming the system" in Newton's Playground

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Abstract. This paper describes the current status of ongoing research looking into students' "gaming the system" behaviors in an open-ended learning environment—the game Newton's Playground—in relation to their physics learning, enjoyment of the game, and persistence. Our next step is to code students' gaming behaviors and then compare learning via pretest and posttest scores. We'll also examine gaming behaviors relative to enjoyment of the game and persistence. Findings can inform improvements to Newton's Playground (and other games) and guide the design of scaffolding for students in other OELEs.

Keywords: game the system behaviors, game-based learning, physics learning, persistence

1 Introduction

Open-ended learning environments (OELEs) are technology-rich environments that allow learners to participate in authentic problem solving activities, interact with the system by actively making choices, and apply cognitive and metacognitive skills to assess and monitor their learning processes [5]. Providing players the freedom to explore the environment and make choices are essential features of OELEs, which render the environment engaging and meaningful.

Well-designed digital games share similar features with such environments [1]. For example, Gee (2003) discusses properties of good games, such as interactive problem solving, adaptive challenges, feedback, and control that are aligned with learning principles to promote deep and meaningful learning. In games players actively interact with the system by making choices, and this provides a sense of control and ownership to the players. Also, games provide players with complex and interesting problems to solve, allowing freedom in terms of how they reach the solution.

In such wide-open environments, however, it is almost impossible to predict every possible way that learners will interact with the system. Studies have shown that for novice learners, having too much freedom can lead to frustration or unsuccessful learning [5]. This may result in unexpected behaviors by learners such as exploiting loopholes of the system, which is commonly referred to as gaming the system.

Baker (2005) defines gaming the system as "attempting to succeed in an educational environment by exploiting properties of the system rather than by learning the material and trying to use that knowledge to answer correctly (p. 6)." Reasons why learners game the system and how it influences learning have been investigated in various forms of technology rich learning environments, primarily in intelligent tutoring systems [1]. Broadly speaking, learners are more likely to show gaming the system behaviors when (a) they dislike the subject matter, (b) they are frustrated, and/or (c) they lack drive or motivation.

Unlike what happens in learning environments like intelligent tutoring systems, gaming the system is not always viewed negatively in the gaming context. In fact, it can be an important aspect of gaming culture as evidenced by a player proudly sharing certain "tricks" with other players [4]. Therefore, as using games for learning purposes becomes a more common practice in the broader education community, it is important for educators and researchers to understand why players would game the system and how such behavior influences learning.

2 Context

We propose to investigate gaming the system behaviors in a game called Newton's Playground (NP) [6]. NP is a two-dimensional computer game designed to assess and support qualitative physics and persistence. The core mechanic of the game is to guide a green ball to a red balloon by drawing physical objects and simple mechanical devices (i.e., ramp, lever, pendulum, springboard) on the screen that "come to life" once drawn. We call these devices "agents of force and motion" since they trigger or change the direction of motion. There are four types of agents that are categorized in terms of unique features and underlying physics principles: ramp, lever, pendulum, and springboard.

A ramp is any line drawn that guides a ball in linear motion, and it is commonly used for problems that require transfer of potential energy to kinetic energy. A lever rotates around a fixed point usually called a fulcrum or pivot point, and it is used to move the ball vertically. A swinging pendulum directs an impulse tangent to its direction of motion, which is used to exert a horizontal force. A springboard stores elastic potential energy provided by a falling weight, and is used to move the ball vertically.

As the use of these agents provides evidence for students' physics understanding, NP has a built-in evidence identification system that automatically categorizes (with > 95% accuracy when compared with human ratings) the type of agent based on salient features of drawn objects by students. Even though there is no absolute correct or incorrect way of solving problems, they are "probable agents" of force and motion that experts (or the game designers) expect players to use in given problems.

In the fall of 2012, we had 165 ninth graders play the game for around 4 hours (across a one-week time frame). We also administered pre- and posttests of physics to measure improvement of students' qualitative physics as the result of playing NP. As part of the study, we observed that some players came up with various ways to exploit the system, and we categorize them as stacking lines, breaking the system, and cutting corners (Table 1). We define these types of solutions as gaming the system behaviors in NP because these solutions (a) exploit loopholes in the system, and (b) do not require application of appropriate physics principles.

Table 1. Gaming the System in Newton's Playground

Gaming the system behaviors	Features
Stacking	Players consecutively draw short lines right below the ball to lift up the ball to the balloon. Players are likely to show this behavior when the balloon is above the ball.
Breaking the system	Players draw random lines across the given objects until the system crashes and acts randomly. Players are likely to show this behavior when either the balloon is above the ball or the path to the balloon is constrained by obstacles
Cutting corners	Players draw a line quickly beneath the ball that spans over to the balloon. Players are likely to show this behavior when the ball is moving away from the balloon or the starting point of the ball is higher than the balloon.

3 Research Questions

The present study aims to address the following questions:

1. How does gaming the system in NP influence players' physics learning?
2. How does gaming the system in NP relate to players' enjoyment of the game and persistence?

Our hypotheses are:

1. For most students, gaming the system is negatively related to players' physics learning;
2. For most students, gaming the system is negatively related to players' enjoyment of the game and persistence.

4 Method

First, two human raters will replay (with the "level replay" function in the game) all log files of a set of 16 problems that are solved by over 60% of the students, and manually code occurrences of gaming the system behavior related to the three identified categories (i.e., stacking, breaking the system, and cutting corners). Second, we will identify three different subgroups of players in terms of frequencies of the gaming the system behaviors (i.e., none, some, and a lot). Third, we will analyze differences among these subgroups in terms of physics learning (via pretest to posttest gains), enjoyment, and persistence. Note that we already have the data collected, and just need to conduct the observation of replay files, code the behaviors, and analyze the data.

5 Discussion and Implications

To ensure that learners with varying abilities can all benefit from playing games that are designed for learning, we need to identify any subgroups of students who may become lost in the environment and simply try to "cheat through" the problems without applying appropriate knowledge and skills. If our hypotheses are established, we will need to devise appropriate scaffolds in NP to minimize the gaming behavior and thus maximize learning and enjoyment. Potential scaffolds that may fit in NP include tutorial videos and visual aid function. For example, for the visual aid function, dotted lines will show up on the screen upon request, which provide students with clues for appropriate agents rather than having them get stuck and thus frustrated.

However, considering NP is still a game, any decisions regarding scaffolds need to balance with features of good games. That is, we need to be careful about how much scaffolds we provide, and how they are presented to students because poorly designed scaffolds in the game may spoil engaging features of the game (e.g., challenge, control, and adaptive difficulty).

In conclusion, gaming the system behaviors have not been fully investigated in the context of games for learning, and we first need to understand how these behaviors influence learning—i.e., are they always maladaptive or can they sometimes yield positive outcomes? We hope that this study will provide us with useful information about learners' gaming the system behaviors in NP in relation to learning and enjoyment, and also shed light on appropriate forms of scaffolding to be used to prevent such behaviors, if warranted. The findings from this study may also be of interest to researchers who are interested in gaming behaviors and possible scaffolding in OELEs.

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