



Does agency matter?: Exploring the impact of controlled behaviors within a game-based environment



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ABSTRACT

When students exhibit control and employ a strategic plan of action over a situation they are said to be demonstrating agency (Bandura, 2001). The current work is comprised of two studies designed to investigate how agency manifests within students' choice patterns and ultimately influences self-explanation quality within the game-based system iSTART-2. In Study 1, 75 college students interacted freely within iSTART-2 for 2 h. Random walk and Entropy analyses were used to quantify the amount of control demonstrated in students' choice patterns, as well as to determine the relation between variations in these patterns and self-explanation performance within iSTART-2. Overall, students who demonstrated more controlled choice patterns generated higher quality self-explanations compared to students who exhibited more disordered choice patterns. This link between performance and controlled choice patterns is hypothesized to be driven, in part, by students' experiences of agency. That is, engaging in controlled patterns should be advantageous only when doing so is a result of students' strategic planning. In Study 2, this hypothesis was tested by assigning 70 students to a choice pattern (i.e., controlled or disordered) that had been yoked to students from Study 1, thus removing students' ability to exert agency over the iSTART-2 system. Results revealed no differences in self-explanation quality between the groups assigned to controlled and disordered choice patterns. Collectively, findings from these studies support the notion that success within game-based systems is related to students' ability to exert agency over their learning paths.

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1. Introduction

Everyday, people make decisions, set plans, and exert influence over their daily lives. Individuals control a multitude of situations through their choices, decisions, and strategic plans. They exert *agency* (Metcalfe, Eich, & Miele, 2013). Indeed, agency (or a lack thereof) is a pervading aspect of our lives.

According to Bandura (2001), there are four main features of human agency: intentionality, forethought, self-reactiveness, and self-reflectiveness. *First*, agency refers to a *deliberate* action or set of actions, which are purposefully enacted according to a specific plan. *Second*, agency involves forethought. A person exerting high levels of agency will have set goals and plans for how to obtain these goals before carrying out any actions. *Third*, agency is self-reactive, emerging from a person's motivation to succeed and self-regulate. *Finally*, agency is self-reflective, such that the person who is exerting agency is metacognitively aware of the goals, plans, and behavior adjustments necessary to complete a task. Combined, these four components portray agency as a dynamic behavior that involves intentionality, metacognition, and planned sets of behaviors designed to accomplish a goal. Considering agency in this light, it is not surprising that individuals who demonstrate agency over their environment generally lead more successful lives compared to those people who do not (Bandura, 2001; Ford, 1992).

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2. Educational environments and student agency

Within the realm of education, agency emerges as an important factor that influences students' engagement and subsequent learning of academic material (Bandura, 1989; Zimmerman, 2008). Indeed, it is a widely accepted belief in the classroom that affording students control promotes their motivation and subsequent learning outcomes (Flowerday & Schraw, 2000). In support of that assumption, students' emotions while learning have been moderately associated with their perceptions of subjective control (Pekrun, 2006; Pekrun, Goetz, Daniels, Stupnisky, & Perry, 2010). According to the control-value theory of emotion (Pekrun, 2006; Pekrun et al., 2010), a greater sense of control is related to students' expressed positive attitudes during a learning task. Consequently, engagement is expected to increase when students are afforded autonomy and control during various academic tasks (Calvert, Strong, & Gallagher, 2005; Cordova & Lepper, 1996; Deci & Ryan, 1985; Hidi & Renninger, 2006). Cordova and Lepper (1996), for instance, found that learners who were afforded more opportunities to exert control over a learning task reported stronger motivation and interest and showed better performance on a subsequent math test. Similarly, Calvert et al. (2005) reported that students who were given more control over a computer-based storybook reported greater interest in the task and were more attentive to the material than students who were given more explicit directions by adults. These studies provide growing evidence that agency during learning has the potential to enhance motivation, interest, and attitudes, all of which are associated with positive learning outcomes.

Adaptive learning environments have attempted to leverage these positive effects of agency by incorporating various elements such as customization, games, and "choose your own adventures." These game-based elements are designed to promote students' feelings of agency and by consequence enhance motivation, performance, and learning outcomes (Cordova & Lepper, 1996; Jackson & McNamara, 2013; Snow, Jackson, Varner, & McNamara, 2013). For example, providing learners with control over when and how long they engage with different lessons (i.e., their learning trajectory) in a system can improve learning outcomes (Tabbers & de Koeijer, 2010). Even giving control over educationally superficial features of a system (e.g., choosing the images that will be depicted by the system) allows learners' experiences to match their personal preferences. This in turn can decrease the effort required to engage in a task and subsequently increase involvement and learning (Corbalan, Kester, & van Merriënboer, 2009; 2011). In this way, students can feel as though they are exerting control over their environment with minimal changes to the learning task itself.

Game-based systems are particularly germane to the issue of a student's sense of agency during learning. By leveraging the mechanics and features found in popular, non-educational games, learning environments infused with games naturally afford students the ability to exert influence on the learning environment (McNamara, Jackson, & Graesser, 2010). Indeed, a number of game features have been adapted from popular games to educational games with the purpose of increasing player engagement and the likelihood of players experiencing agency in a system. For instance, many popular video games allow players to make choices within the environment, follow non-linear paths through the game (e.g., Grand Theft Auto V) or select between several available mini-games (e.g., Nintendo Land). Likewise, educational games often include choices for how to progress through a system as a means to support player agency and increase replayability (Snow, Jacovina, Allen, & McNamara, 2014; Spires, Rowe, Mott, & Lester, 2011). Popular commercial games frequently allow players to customize the visual appearance of game features to their preference (e.g., a player's avatar in World of Warcraft), and this game-based feature (i.e., choice) has been associated with increased immersion and intention to replay a game (Schmierbach, Limperos, & Woolley, 2012; Teng, 2010; Yee, 2006). Similarly, personalization enhances students' motivation and learning outcomes (Cordova & Lepper, 1996).

One of the most effective features that has been incorporated into educational games is user choice. Choices made by individual players have the potential to provide students with a sense of agency, as they are engaging on intellectual or emotional levels and prompt players to persist in their play (Schönau-Fog & Bjørner, 2012). Mechanics and features that promote engagement in these ways are found in educational games such as *Crystal Island* (Lester, Mott, Robison, Rowe, & Shores, 2013) and *Quest Atlantis* (Barab, Pettyjohn, Gresalfi, Volk, & Solomou, 2012), where students are immersed in 3-D game environments. In *Crystal Island*, for example, players control an avatar and explore an island where an illness has recently spread. Players interact with both the environment and other game characters to discover information about this outbreak, and in the process, learn microbiology course content. An important advantage for *Crystal Island* over traditional instruction is that it can promote a strong sense of agency, as students have control over how they obtain knowledge in this environment. A study examining students' performance during the game and on posttest content questions found that students who did well in the game also did well at posttest, and these students were more successful at gathering information during play (Rowe, Shores, Mott, & Lester, 2010). Students who did not do as well in the game, however, also scored lower at posttest and demonstrated less successful information-gathering behaviors. These findings suggest that when students successfully take agency over their learning experience, they achieve higher outcomes in terms of learning the target material.

Despite the generally positive effects of system choices, research suggests that the inclusion of user control may not be universally beneficial for all students (Katz, Assor, Kanat-Maymon, & Bereby-Meyer, 2006). For instance, while some studies have shown added elements of user choice to be associated with positive outcomes (Cordova & Lepper, 1996; Reynolds & Symons, 2001), others have shown inconsistent (Flowerday & Schraw, 2003), neutral (Parker & Lepper, 1992), or negative effects (Flowerday, Schraw, & Stevens, 2004; Iyengar & Lepper, 2000). One reason for these conflicting results may be that users react differently when presented with increased levels of control. Some students may regulate their behaviors and exert control over the environment—inspiring strong feelings of agency—while others may struggle to set goals and make decisions (Zimmerman, 1990). The ability to exert control during a learning task is challenging for many students, as they often struggle to actively monitor their behaviors (Ellis & Zimmerman, 2001). Overall, research suggests that the inclusion of user control (e.g., choice) has the potential to increase learning outcomes among students; however, these effects may vary based on individual differences in users' ability to control their behaviors (McNamara & Shapiro, 2005).

3. Assessment of student agency

Students' inconsistent ability to exert control over their environment has posed an assessment problem for researchers, as it is difficult to capture fine-grained behavior variations. Traditionally, students' feelings of agency have been assessed through self-reports (Ellis & Zimmerman, 2001; Zimmerman, 1990). These direct measurements are static in nature and often miss out on behavior patterns that emerge over time. An alternative to self-report metrics is the use of stealth assessments (Shute, 2011; Shute, Ventura, Bauer, & Zapata-

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