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Serious Games and Growth Mindsets:
An Experimental Investigation of a Serious Gaming Intervention

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ABSTRACT

This study applies implicit person theory (IPT) to serious gaming. IPT scholars argue that individuals hold one of two views regarding perceptions of ability: growth mindset (abilities are malleable) or fixed mindset (abilities are unchanging). Extant literature demonstrates the many educational benefits afforded to learners who hold a growth mindset. As such, a serious training game was designed to move players' beliefs about their abilities toward growth. To test the efficacy of the serious game on shifting mindsets, researchers ran an experiment in which college freshmen (N = 95) either played the game or participated in mindset activities other than a game. Results demonstrate that students who played the game reported higher levels of growth mindset immediately following and six weeks after playing the game than students who did not play the game. Suggestions for game development for the purpose of fostering a growth mindset are discussed.

KEYWORDS

Educational Gaming, Educational Intervention, Implicit Person Theory, Mindset, Serious Gaming

INTRODUCTION

According to U.S. News & World Report (2018), at least one in three first-year college students will not return to school after their freshman year. These poor retention rates have endured for more than a decade and disproportionately affect low-income, first-generation, and minority students. While reasons for leaving college are often complex and personal, one common reason disadvantaged

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freshmen drop out of school at a higher rate than their counterparts is academic struggle (U.S. News & World Report, 2018). This problem implores a solution that addresses sweeping patterns of college attrition while also attending to students' ability to persist in the face of struggle.

Existing research proves that nurturing students who believe their achievement is based on their effort rather than their innate ability improves academic outcomes of disadvantaged students (Dweck, 2006). Many efforts have been made to shift students' beliefs about their own ability toward the importance of hard work and challenges in the pursuit of growth. Most of these efforts rely on informed teachers, trainers, and practitioners to implement the shift in their schools, making the efforts difficult to transfer across several schools and challenging to sustain. In order to address the issues of retention due to achievement gaps and sustainability of training across schools, we have created a serious video game to move students away from a belief in natural, fixed abilities and toward a belief that abilities change, develop, and grow over time.

Implicit Person Theory

Much of the research concerning learners' assumptions and expectations about their ability is rooted in Dweck's (2006) work on Implicit Person Theory (IPT). IPT explained that a person's receptiveness to learning is a function of a set of assumptions and expectations about a person's own ability and the ability of others. According to the theory, individuals' thoughts about ability fall into one of two categories: entity or incremental. Entity theorists (commonly referred to as learners who hold a fixed mindset) assume that their own and others' abilities are fixed, unchanging, and constant. Individuals who hold a fixed mindset are more likely to attribute intellect, morality, and ability to their personality. On the other hand, incremental theorists (often referred to as learners who hold a growth mindset) view abilities as changeable, malleable, and subject to development. Incremental theorists are more likely to believe that their intellect, morality, and abilities can change and grow with hard work. IPT research continues to support that learners' assumptions about their own ability influence the effectiveness of their learning (Bai & Wang, 2020; Xu et al., 2021). Overall, the decades of research on IPT reveal a sweeping number of benefits enjoyed by incremental theorists (those with a growth mindset) in comparison to entity theorists (those with a fixed mindset; Dweck, 2006).

Achievement Goals and Implicit Theories

The achievement differences between entity and incremental theorists are rooted in achievement goals. Learners focus on either performance goals or learning goals when pursuing achievement. Learners who focus on performance goals are aligned closely with entity theorists in that they are most interested in upholding positive judgements of their ability and avoiding negative judgements (Nicholls, 1984). As such, entity theorists' pursuit of performance goals leave them avoiding new challenges and ignoring useful feedback that might be perceived as a negative judgment but ultimately would improve their learning (Dweck, 2006). Alternatively, learners who focus on learning goals are aligned with incremental theorists in that they are interested in increasing their ability or mastery of new tasks (Nicholls, 1984). Incremental theorists' pursuit of learning goals leaves them welcoming new challenges and inviting feedback to help move them toward mastery (Cutumisu, 2019).

Attributions and Implicit Theories

Implicit theories create the meaning framework in which attributions occur (Zhang et al., 2021). Entity theorists attribute their own and others' performance to ability, while incremental theorists attribute performance to effort (Dweck, 2006). The difference in the attributions learners make about their own ability is magnified by learners' reactions to setbacks (Zhang et al., 2021). In the face of setbacks, entity theorists' focus on ability can impair their motivation and performance (Xu et al., 2021), undermine achievement (Yeager et al., 2019), and result in disengagement (Soland et al., 2019). Entity theorists respond to setbacks with self-handicapping behavior, helplessness, negative affect, negative self-judgments, lack of persistence, and performance decrements (Babij et al., 2019).

Similarly, in the face of transgressions, entity theorists are less likely to accept responsibility for the transgression than their incremental theorist counterparts (Schumann & Dweck, 2014). In sum, when faced with a setback, entity theorists are likely to give up easily, while incremental theorists are likely to persist.

IPT Manipulations

A robust body of research reveals that implicit theories can be manipulated experimentally. Existing research demonstrates that learners' mindsets can be shifted toward growth by receiving growth-mindset–oriented feedback (Cimpian et al., 2007), having participants read scientific testimonials, and showing students a video about the brain's ability to grow like a muscle (Yeager et al., 2019). Additionally, scholars have demonstrated the effectiveness of self-persuasion as it applies to inducing implicit theories of the self. Aronson et al. (2002) explained how change in the beliefs and attitudes induced by direct persuasion from others are often small and temporary, while self-persuasion gives participants a chance to reflect on their own experiences. Manipulations using one or several of these strategies have been successful at shifting mindsets in as little as a 30-minute training session (Adame et al., 2018).

Serious Video Games

Serious games are a seriously big business. In 2020, it was estimated that the serious game market was valued at USD 6.29 billion and expected to reach a value of USD 25.54 billion by 2026 (ReportLinker, 2021). The boom in serious games is understandable considering several variables including: investment in serious gaming from large corporations, government programs boosting educational gaming in multiple countries, and the emergence of the COVID-19 pandemic and subsequent nationwide lockdowns (ReportLinker, 2021). Given these variables, the variety of ways in which games are used has widened and paved the way to the development of serious gaming (Krath et al., 2021).

Serious gaming is defined as games that have an explicit educational purpose rather than used simply for entertainment (Laamarti et al., 2014), although the user may not be aware of the explicit educational purpose (Susi et al., 2007), and the presence of theoretical manipulations during game play (Krath et al., 2021). Compared to traditional educational materials like textbooks or lectures, serious games aim to engage users by balancing learning and fun to maintain high motivation levels (Lee et al., 2012).

Because serious games are educational *and* entertaining, one might call serious games edutainment (Susi et al., 2007). Yet, serious games are considered "more than just 'edutainment'" (Michael & Chen, 2006, p. XV), because they can also teach, train, and educate (Krath et al., 2021). Thus, serious gaming has become increasingly popular for educational purposes (Zhonggen, 2019). Serious gaming involves multiple approaches to engage learning in the user (Le Marc et al., 2012), paralleling the ways in which those who grew up with the Internet acquire knowledge (Prensky, 2007). Specifically, serious games have been applied to a wide variety of educational areas, such as medical education (Ijaz et al., 2019) and disaster risk reduction (Fleming et al., 2020).

Serious gaming affords a unique opportunity to reach demographics that may otherwise avoid the educational content, and to do so in a way that holds the user's attention (Breuer & Bente, 2010). Serious games have not only been used as educational tools for delivering simple concepts, but have also shown great promise in teaching complex functions (Dunbar et al., 2014). Benefits of games include increased student involvement, development of skills, and application of such skills in practical contexts outside of gameplay (Almeida & Simoes, 2019). Successes, like the above outcomes, stem from the games being developed in ways that promote experiential learning through simulations of decision making and dynamic interactions (Dunbar et al., 2014).

Unlike traditional approaches to education, gaming provides a student-centered medium for learning (Almeida & Simoes, 2019). Games foster feelings of control in the player, creating a sense of freedom that encourages them to use their simulated experience to develop new skills and knowledge

(Mouaheb et al., 2012). Additionally, simulated game environments create spaces in which the risk of failure is minimized, allowing the player to devise creative solutions (Lee et al., 2012). With technological advancements, the popularity of serious games continues to expand, offering educators new solutions for engaging learners; with this growth, however, comes a need for research on the efficacy of gaming approaches to education (de Freitas & Liarokapis, 2011).

Serious Video Games and Implicit Theories

Serious video games are a viable method to manipulate mindsets for two main reasons. First, the feedback mechanism afforded in the serious video game context is unique from the traditional learning environment. Serious video games allow learners to receive real-time, immediate feedback on decisions they make in the game. When this feedback is structured in a way that emphasizes the value of learning from mistakes, the feedback functions as a way to help students attribute meaning to their incorrect answer as a person who is still learning and growing, rather than a person who does not have the ability to answer correctly. Therefore, the feedback functions as a mini-mindset manipulation. Serious video games also offer a context where this feedback can occur in a non-threatening way (Lee et al., 2012). In a traditional setting, learners may feel threatened by a teacher's identification of a wrong answer. In a serious video game, this corrective feedback may feel more playful and less personal due to the game context and the lack of authority in the feedback process.

Second, serious video games offer a context where challenges are expected, therefore offering learners a safe place to practice accepting challenging tasks. Existing research by O'Rourke et al. (2014) illustrated that when in-game incentive structures reward effort, strategy and incremental progression in accordance with values of a growth mindset, learners become more persistent and use more strategies for solving the game's problems.

While researchers have explored the role that IPT has on student persistence while playing video games (Lee et al., 2012) and how incentive structures influence student persistence in game play (O'Rourke et al., 2014), to our knowledge, no existing research has explored if serious video games are an effective method for manipulating student mindsets.

Thus, this study examines the following hypotheses:

H1: Students in the serious video game treatment group report higher levels of growth mindset immediately following the mindset manipulation than students in the comparison group.

H2: Students in the serious video game treatment group report higher levels of growth mindset six weeks after the mindset manipulation than students in the comparison group.

METHOD

Participants

Participants ($N = 95$) included freshmen students enrolled at a large southwestern university. Participants included 42 males and 53 females, ranging in age from 18 to 22 years of age ($M = 18.14$, $SD = .70$).

Participation was voluntary. Students were assigned randomly to either a treatment ($n = 57$) or comparison ($n = 38$) group. Students assigned to the treatment group played a serious video game to induce a growth mindset. Students in the comparison group were presented with the same foundational content of the video game, but did so through watching educational videos, reading a news article, and writing a letter.

Procedures

Participants were notified of an opportunity to participate in an experiment through announcements made by the principal investigator in introductory classes across the university. Interested students

were offered several time slots from which to choose to participate in the experiment. Each time slot was assigned randomly to condition. Students were offered extra credit for their participation.

Upon arriving to the laboratory, a research assistant greeted potential participants, assigned the student a unique participation number, and directed the student to a computer. Once in front of the computer, the research assistant described the three steps of the study: a pre-test, the manipulation, and a post-test. Each of these steps is described in detail in the following paragraph.

First, students clicked on a link on their desktop that directed them to an online Qualtrics survey. In the survey, students were presented with an online informed consent form in accordance with institutional review board policies. If students agreed to participate, they completed the Implicit Person Theory measure (Dweck et al., 1995), filled in their unique participation number, then moved to the next step. Second, students in the treatment group played the game until they completed it. Students in the comparison group watched a series of educational videos, read scientific evidence, and wrote a brief letter providing advice to a struggling student. In the third and final step, all participating students clicked on another link on their computers to open a survey, completed the IPT measure a second time, answered demographic questions, and entered their unique participant identification number. The final step of this survey asked students to complete information for extra credit.

Six weeks after their initial participation, students received an email with a follow-up Qualtrics survey. In the survey, students answered the IPT measure again, filled in their unique participation number, and provided information for a second extra credit opportunity.

Measures

Implicit Person Theory Scale

The treatment's effectiveness in shifting students' implicit theory of intelligence was tested by having participants complete the nine-item implicit person theory measure (Dweck et al., 1995). Each item is measured on a six-point Likert-type scale (1 = *strongly disagree* to 6 = *strongly agree*). Sample items include: "Your intelligence is something about you that you can't change very much" and "People can do things differently, but the important parts of who they are can't really be changed." Answers were recoded so high scores represent an incremental IPT. Heslin et al. (2006) demonstrated that the validity and reliability of the scale is well-established. Cronbach's α for this study was .86 (all students before treatment), .93 (all students immediately following treatment), .92 (all students 6 weeks after treatment).

Video Game Treatment Manipulation

Advance U is a serious game developed to introduce students to implicit person theory and, in so doing, persuade students to move their implicit beliefs about ability toward incrementalism. The game was designed by a team including game developers and researchers with the goal of increasing the academic success of at-risk students. Game design was funded by [Redacted] to help students prepare for and pursue a college education. The funding source had no involvement in the design, writing, or submission of the research.

In this game, a new program has been enacted at a fictional educational institution, McLaren Academy. The president of McLaren Academy is excited about a new machine called *The TALENT Machine*, which measures a student's natural talents and then determines the job and related major best suited for that student. Unfortunately, this machine ignores a human's capability to learn and grow, and the game limits the student's options to only their innate skills. Despite *The TALENT Machine*'s shortcomings, the president of the academy is requiring all students to use the machine to determine their major and career path.

To reclaim their educational autonomy and stop the machine from being adopted by more schools, as students of McLaren Academy, game players must prove that *The TALENT Machine* will not work. To argue against the machine, students must learn about implicit person theory, then they must use that knowledge to prove the machine's results are invalid by teaching other students, teachers, and

eventually the school president about how the human mind can continue to learn and grow beyond the limits of one's own natural talents.

Game play in *Advance U: The TALENT Machine* was designed to help students accomplish two main objectives. First, the game was developed to help students explain the concept of mindset. In doing so, students must demonstrate that they can identify their own and others' mindsets based on messages. Second, the game was designed to explain to students how they can change their own and others' mindsets.

Comparison Group Manipulation

One of the goals of this project was to test the effectiveness of the game compared to more traditional methods of manipulating mindset. To this end, the comparison group manipulation included methods of manipulating mindset that have been tested and deemed effective in other research. Students in the comparison group watched a series of three videos about the brain's ability to grow like a muscle, read scientific testimonials, and acted like a mentor by writing an email offering advice (Aronson et al., 2002). The comparison group manipulation was designed to provide equal content to that of the video game. In other words, care was taken to choose videos and activities for the comparison group that covered an equal amount of content as the video game. Because of the nuances of learning game play and navigating the game, the time taken to teach the concepts to the comparison group was not as long as the treatment group.

Manipulation Check

As mentioned, all students completed the implicit person theory scale before the mindset manipulation and again after the manipulation. One purpose of this repetition was to test whether the students reported marked change in their implicit person theory after engaging in the experiment. Researchers expected all students to move toward growth mindset after they engaged in either the game or the educational videos. A paired-samples *t*-test was conducted to compare the implicit person theory scores of all students before and after the manipulation. Results indicated a significant change in all students' belief in incremental intelligence before ($M = 3.93$, $SD = .82$) and after the manipulation ($M = 4.83$, $SD = .92$), $t(94) = -13.22$, $p = .000$, $d = 1.03$.

Random Assignment

Since all students were randomly assigned to either the treatment or comparison group, it would make sense that there would be no difference in students' initial IPT scores. An independent-samples *t*-test was conducted to compare the treatment group's initial IPT and the comparison group's initial IPT. Results indicated no significant difference in the initial IPT of students in the treatment group ($M = 4.02$, $SD = .78$) and students in the comparison group ($M = 3.79$, $SD = .87$), $t(93) = 1.41$, $p = .162$. The lack of difference between the treatment and comparison groups' reported initial IPT indicated that random assignment worked.

RESULTS

The main goal of the experiment was to test the effectiveness of a video game to move students toward a growth mindset in comparison to other methods of manipulation. The goal of the experiment was achieved.

The first hypothesis predicted students who played the video game would report higher levels of growth mindset immediately following the treatment than students in the comparison group. An independent-samples *t*-test was conducted to compare the two groups' growth mindset immediately following participation in the experimental manipulation. Results indicated a significant difference in the reported mindset for the treatment ($M = 5.11$, $SD = .78$) and comparison ($M = 4.42$, $SD =$

.98) groups immediately following the manipulation, $t(93) = 3.76$, $p = .000$, $d = .78$. Hypothesis 1 was supported.

The second hypothesis predicted students who played the video game would report higher levels of growth mindset six weeks after the treatment than students in the comparison group who watched videos, read scientific evidence, and wrote a letter about mindset. An independent-samples *t*-test was conducted to compare the treatment and comparison groups' growth mindset six weeks after participation in the experimental manipulation. Results indicated a significant difference in the reported mindset for the treatment ($M = 4.40$, $SD = .80$) and control ($M = 4.04$, $SD = 1.14$) conditions six weeks after the manipulation, $t(60.85) = 1.72$, $p = .046$, $d = .37$. Hypothesis 2 was supported.

DISCUSSION

The goal of this experimental investigation was to show whether a serious game on growth mindset would influence students' mindsets when compared to students who participated in more traditional forms of mindset training. This experiment revealed that students who played the serious game reported higher scores of growth mindset immediately after and six weeks following the game play than students in the comparison group who watched videos, read scientific evidence, and wrote a letter. This study contributes to theory and practice in three main ways.

Scalability of Mindset Training

The idea of shifting students' mindsets via serious games provides a scalable treatment across large populations, such as college freshmen. As mentioned, retention among college freshmen is a problem in the United States (U.S. News & World Report, 2018). This challenge of retaining students may become even more pronounced as college students are forced to move to remote learning due to goals to contain the spread of COVID-19 on college campuses. Many colleges do their best to retain students beyond their first year of school, but have a hard time doing so in a manner that is scalable and sustainable. Most existing mindset manipulations require resources that challenge the scalability of the efforts such as changing curricula, training teachers, and consuming classroom time (Yeager et al., 2019). A gaming intervention would not require such expansive resources. The application of serious games in contexts outside of education including healthcare (Ijaz et al., 2019) and government (Fleming et al., 2020) demonstrate that gaming can be scaled across populations and organizations to evoke behavior change over time, and when face-to-face interactions are not possible or ideal (ReportLinker, 2021). This current research supports that this serious game intervention is an effective method to boost resilience in what is otherwise a population susceptible to poor retention rates.

Sustaining a Growth Mindset Over Time

The findings inform the role that serious games have on the sustainability of mindset manipulations over time. Students who played the serious game sustained their beliefs about the malleability of ability, the importance of hard work, and the role that challenge has on making improvements six weeks after the mindset manipulation, while students in the comparison group did not sustain the beliefs about mindset over the six-week lapse between measurements. As such, serious games seem to be a strong method of changing students' mindsets and sustaining these changes six weeks after the game play. This study investigated the serious game as played from beginning to end at one time. Other research demonstrates that results from serious video game trainings are more sustainable over time with repeated game play (Dunbar et al., 2014). This serious game is designed to be played over time and, as such, game play outside of the laboratory setting may result in stronger changes than the one-time play in the laboratory.

The Role of Interactions on Mindset Manipulations

This research contributes to theory by demonstrating the influence of interactions on one's mindset. A person's beliefs about ability are rooted in messaging, and often manifest in interactions in the form of feedback (Adame, 2018). Many current mindset manipulations involve a one-way dissemination of information from the researcher to the learner, without allowing the learner to get feedback as they test their understanding of how mindset concepts apply to their own attitudes and behaviors. Even when research participants are asked to write as part of the manipulations (i.e., Aronson et al., 2002; Yeager et al., 2019), the participant does not receive feedback on their written passage. Other manipulations provide participants with feedback (Yeager et al., 2014), and do so not based on the participant's performance but rather based on the random group to which the student was assigned at the outset of the experiment. Unlike these existing mindset manipulations, this serious video game invites participants to learn about mindset, requires them to apply these lessons to interactions with others throughout the game, and identifies when they did not answer in a manner consistent with a growth mindset. In this way, learners receive real-time feedback about their understanding of mindset. Until the player is able to make choices in the game that privilege effort, growth, and change over static, innate ability, the player will not conquer the game.

Recent research on serious games in the medical context demonstrates that the feedback mechanism in games allows for growth and change that is not always possible in real-life contexts. Cutumisu et al. (2020) implemented a serious game with feedback to train medical students to administer neonatal cardiopulmonary resuscitation (CPR). Results indicated that students who practiced in the serious game context were more effective at administering CPR to the babies than students who learned face-to-face. Researchers attribute this learning to the non-threatening nature of the feedback in the gaming context.

This feedback function of the game environment may be instrumental to shifting and sustaining growth mindsets, especially among students who begin game play with strong beliefs that ability is innate. If a student begins a mindset manipulation with an identity entrenched in fixed mindset values learned from years of repeated messages from parents, teachers, coaches, and others, they may be less likely to engage in video and writing manipulations in a meaningful way. When this lack of engagement is met with little to no consequence due to the lack of feedback, the student might not be motivated to shift their mindset beyond the scope of the study. Serious games provide a unique context where a productive response to feedback is both rewarded throughout game play and necessary to conquer the game, demonstrating how messages and interaction shape mindset over time.

Limitations

While we do know that the serious game was successful in changing attitudes about ability, we do not know how, if at all, the video game influenced player behavior outside of game play. Students may hold attitudes about ability as malleable, changing, and a product of hard work, and, at the same time, not act in ways that mirror this attitude change. Dweck (2006) reported that attitude change about mindset does lead to improved achievement outcomes. In order to know the same of the serious game, future research will address the role of serious games to change behavior. In the case of students, researchers might track students' performance in classes over time, request access to grade point average data, or seek other report data from teachers and parents.

Relating to the previous point, context matters. Students may have reported higher levels of growth mindset because they recognized how they should answer the questions based on the memorable principles presented to them in the serious game. Based on this possibility, students may have responded to the IPT measure in a way that they deemed desirable in the specific context of this research study, but their responses to the IPT measure may change when administered in a different context (i.e., in a classroom, outside of the confines of the experiment, or at home). In order to understand how such manipulations influence students' overall mindsets, future research should explore how the context of the IPT measure (i.e., location, administrator, format) might influence how students respond to

the questions. Similarly related to context, the research occurred in a controlled laboratory setting and game play occurred at one time. Future research should explore the effects of the serious game when played in an organic setting over multiple time periods.

Participants in this study included only freshmen college students at a four-year university. As such, it could be the case that these students hold more malleable mindsets of ability and effort than students who do not self-select into the pursuit of a four-year degree. Future research will investigate the effects of the game with other audiences, including students at a two-year community college, high school seniors, and students transitioning from junior high to high school.

CONCLUSION

This study attempted to expand IPT research to serious game design. Students who engaged in serious game play reported higher levels of growth mindset immediately following and six weeks after game play in contrast to their comparison group counterparts. The game design and the results of this research fill an important void in the IPT literature. According to Good et al. (2012), "It is particularly important to better understand how entity and incremental *messages* may be *communicated*" (p. 714, emphasis added). This research satisfies the call by offering data that explores the effects of serious game on communicating and manipulating mindsets. Results point to effectiveness of growth mindset manipulations in the serious gaming context. More research is needed to explore IPT in the serious gaming context.

CONFLICT OF INTEREST

The authors of this publication declare there is no conflict of interest.

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