Developing a growth-mindset pedagogy for higher education and testing its efficacy

Miguel A. Sahagun [*], Randy Moser, Joseph Shomaker, Jenna Fortier

High Point University, One University Drive, High Point, NC, 27268, USA

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ABSTRACT

Choosing the right teaching pedagogy is the first step a teacher can take to ensure that students retain course content. This research developed and tested a growth-mindset teaching pedagogy that helps undergraduate students develop a growth-mindset belief system about their own abilities. Students might believe that their personal attributes and qualities are carved in stone, a fixed mindset, or they might believe they can cultivate, grow, and improve them through their efforts, a growth mindset. To validate a psychology-based growth mindset pedagogy, a pretest-posttest control group design was used. We implemented this growth-mindset teaching pedagogy in 17 sections in two different courses, and we used 14 additional sections that utilized lecture style teaching as control groups. Students exposed to the growth-mindset teaching pedagogy improved their growth-mindset beliefs by 3.44% and decreased their fixed-mindset by 3.48% compared to lecture style teaching.

1. Introduction

How can professors encourage college students to learn content and not just memorize it just before taking an exam? Every professor faces this challenge daily, and although they strive to find creative ways to deliver content, they must also consider that students' mindset plays an important, and perhaps sometimes neglected, role.

Mindsets are assumptions, beliefs, and methods held by people or groups of people. Whether we realize or not, these beliefs are significant factors in what we desire and how successful we are in fulfilling those desires (Dweck, 2016; Gollwitzer, 2012). In other words, our beliefs affect every part of our lives. Overcoming daily challenges is facilitated by the activation of the correct mindset (Gollwitzer & Keller, 2016). Although mindsets are strong, they exist only in our minds, so we have the power to change them. Mindsets can be positioned on a continuum from fixed-mindset to growth-mindset. People with a fixed mindset believe that their personal attributes and qualities are carved in stone, and those with a growth mindset believe they can cultivate, grow, and improve their attributes and abilities through effort, application, and experience. Simply put, a growth-mindset is the belief that personal attributes can be developed, as opposed to being fixed, deep-seated traits (e.g., intelligence). Thus, people who lean predominantly toward a growth-mindset can be categorized as having a growth-mindset. This is a

mindset that transforms failure into an opportunity to learn, whereas a fixed-mindset assumes that personal attributes are innate and can be neither changed nor developed (Dweck, 2016), and failure is due to factors outside an individual's control. Thus, people who lean predominantly toward a fixed-mindset can be categorized as having a fixed-mindset. In this mindset, failure results in a desire to give up and affirms the belief that personal attributes cannot be improved through effort.

Failure in life is inevitable. However, success in all areas of life is determined by how people respond to failure. Do they see failure as an opportunity to learn and improve? Or do they see failure as an obstacle that they will never overcome?

Growth-mindset is, to a relative degree, a new topic and growth-mindset research is still expanding (Claro, Paunesku, & Dweck, 2016; Gollwitzer & Keller, 2016; Mawer, 2014; Sisk, Burgoyne, Sun, Butler, & Macnamara, 2018). Application of growth-mindset qualities extend to the marketing and business worlds where failure is a given (Dweck, 2014). Thus, educators think preparing business students to cope with failure in their careers is paramount. Our research tests whether a teaching pedagogy, implemented in undergraduate level marketing courses, can instill growth-mindset beliefs in students and move them toward the growth-mindset side of the continuum, and, if so, determine its impact.

* Corresponding author. 1829 Johnson Street, Apartment D, High Point, NC, 27262, USA.
E-mail addresses: msahagun@highpoint.edu (M.A. Sahagun), rmoser@highpoint.edu (R. Moser), jshomake@highpoint.edu (J. Shomaker), jfortie1@highhpoint.edu (J. Fortier).

In lecture-style teaching, students tend to try to learn by memorizing the material only to forget it weeks later (Johnson, 1938; Mclntyre & Munson, 2008). To overcome this problem, we developed a new pedagogy we named "growth-mindset teaching" (herein GMST) and implemented it in two undergraduate marketing courses. This teaching pedagogy allows undergraduate students to fail occasionally without penalty, offers multiple opportunities to improve their standing in class, and provides feedback on a weekly basis. Thus, to guide our study, the following research questions were posed:

1. Can we develop a teaching pedagogy that will help undergraduate students develop and/or increase their growth-mindset beliefs? If so, what would that pedagogy look like?
2. What is the impact of this teaching pedagogy on undergraduate students' growth-mindset and fixed-mindset beliefs?

This paper begins with a revision of mindset theory, and then explains key differences between growth-mindset and fixed-mindset. We also present our GMST pedagogy and its implications for undergraduates. Next, we describe the data collection procedures and scales used in the study, after which we present our findings. We conclude with a discussion of the study's limitations and offer suggestions for future research.

2. Literature review

2.1. The role of mindset theory

Why do some students seek merely to be proficient in a subject, while others seek to master it and outperform their peers? Why do some people react to challenges and setbacks with twice the effort, while others become paralyzed and helpless? Can our intelligence and other personal characteristics ever change? The human brain is complex and research on mindset theory seeks to answer these and other questions related to how individuals view their personal attributes (Mahmud, 2017).

A recurring theme through mindset theory is the notion that individuals' attitudes and beliefs about their personal attributes have profound effects on their motivation, decision-making, learning, and performance levels (Sisk et al., 2018). Mindset theory asserts that desiring something enough does not guarantee achieving it. The corollary is when things don't work out as planned, the failure doesn't mean they weren't wanted enough (Healy, 2017). Thus, rather than focusing on desire, mindset theory focuses on the extent to which people believe they can improve certain personal attributes such as intelligence (Healy, 2017).

Mindset theory proposes that people have different perspectives about the malleability of personal attributes, and these mindsets predict key outcomes in both achievement and interpersonal domains (Bernecker & Job, 2019). The theory dives deep into the analysis of the incremental theory of intelligence, which suggests personal attributes can be improved, and the entity theory of intelligence, which proposes that personal attributes are fixed and innate, to determine the implications of both theories for individuals (Dweck, 2012; Dweck & Leggett, 1988; Dweck & Molden, 2008; Molden & Dweck, 2006.). Thus, within the realm of mindset theory, people vary in their beliefs about whether their attributes are fixed or can be modified over time (Bernecker & Job, 2019; Dweck, 2008).

Mindset theory posits that individuals who believe attributes can be improved set goals measured by learning, whereas individuals who believe personal attributes are fixed and innate set goals measured by performance. Individuals who believe their attributes are capable of improvement report a high level of confidence during the goal-setting process and have higher expectations for themselves when measuring their ability to succeed. Individuals who believe personal attributes are fixed and innate seem to stumble seriously when they encounter challenges during the pursuit of their goals, and they report feeling high levels of anxiety when measuring past and future success (Mahmud, 2017). One major differentiator between these two groups of individuals is their response to failure. When individuals who believe personal attributes are fixed and innate fail in the classroom, they are likely to feel helpless and attribute their failure to something they cannot control, whether that be a lack of ability or poor teaching techniques. On the other hand, when individuals who believe personal human attributes can be improved fail in the classroom, they welcome failure as a challenge to learning and growing. Unlike individuals who believe personal attributes are fixed, these individuals attribute their failure to a lack of effort, rather than a lack of ability or poor teaching (Dweck, 2000).

Individuals who believe human attributes are fixed tend to be swallowed up by a desire to perform based on a fixed set of standards, which leads to disappointment and despair as they limit themselves and become more harshly self-critical. Individuals who believe personal attributes are variable and can be improved, on the other hand, lean into opportunities to improve their attributes and, thus, attain higher levels of achievement (Dweck, 2000, 2007, 2008).

These different beliefs among individuals about personal attributes (variable vs. fixed) are the point of origin of the growth-mindset and fixed-mindset theory. Next, we elaborate on the importance of having growth-mindset over fixed-mindset beliefs.

2.2. The importance of having growth-mindset beliefs

In one study, a group of seventh-grade math students were taught about brain plasticity and growth-mindset. The brain was described as a muscle that gets stronger when used and forms new connections every time it is stretched, so they should incorporate this notion into their daily school activities. Another group of seventh-grade math students was not taught about brain plasticity nor growth-mindset, and when compared, the results showed that the group who received the lesson on brain plasticity and growth-mindset improved their math grades, while the group who did not continued to see their grades decline (Blackwell, Trzesniewski, & Dweck, 2007; Dweck, 2008). Analysis of geniuses and those who have made notable creative work has shown that great talent alone was not enough to have achieved what they accomplished. The characteristic that set them apart from other talented individuals is these geniuses' devotion to deliberate practice within their fields (Dweck, 2008, 2008a). This has been called "grit," and it can be the foundation for developing a growth-mindset (Duckworth, Peterson, Matthews, & Kelly, 2007).

Grit is defined as having the perseverance and passion necessary for fulfilling long-term goals (Eskreis-Winkler, Shulman, & Duckworth, 2014). In an educational setting, grit could mean drafting many books or short stories after rejections, completing challenging math problems, or studying various chemical reactions to find a cure for some disease. However, although grit is a key component in the development of growth-mindset beliefs, additional factors such as the use of certain strategies, reward systems, and incremental progress in conjunction with effective teaching positively impacts growth-mindset development (O'Rourke, Peach, Dweck, & Popovic, 2016).

Reward systems are beneficial for instilling growth-mindset ideals and tendencies. Incentive systems have been found to be a factor in academic performance for both high and low-performing students (Chao, Visaria, Mukhopadhyay, & Dehejia, 2017). However, it has also been found that growth-mindset systems best facilitate persistence in performance when the incentive systems provide students with a sense of autonomy; otherwise, these systems will subvert the performance of those who initially attained a high level of accomplishment (Chao et al., 2017).

Incremental progress is also key to developing growth-mindset beliefs. In a study of pharmacy students, participants were given multiple opportunities to display and observe their own incremental progress, and an environment that enabled them to see their advancement. Enabling students to monitor their incremental progress provided a

space for the reinforcement of a growth-mindset (Cooley & Larson, 2018). Observing the incremental progress of one's own advancement in learning paired with an autonomous reward system facilitates persistence in performance (Chao et al., 2017).

Individuals in which a fixed-mindset predominates are classified as fixed-mindset individuals, whereas individuals in whom a growth-mindset is predominant are classified as growth-mindset individuals. However, individuals can alter their mindset, which means fixed and growth mindsets are not permanent. Although these results were not obtained in higher education, previous research has shown that about 40% of students are classified as having a fixed-mindset, 40% are classified as having a growth-mindset, and 20% with contradictory choices are simply not classified (Dweck, 2008).

In sum, having growth-mindset beliefs or not having them plays a critical role in one's upbringing. Thus, it is important that the significance of an individual's mindset be communicated to people starting preferably at a young age (Andersen & Nielsen, 2016). Next, we elaborate the on the rationale and development for GMST and its elements.

2.3. Developing a growth-mindset teaching (GMST) pedagogy

The Growth-Mindset Teaching (GMST) pedagogy was developed to determine if, and which, academic activities can be added and incentivized into the learning process of undergraduate courses to help students develop growth-mindset beliefs. The way in which material is taught in a classroom has a significant effect on how students learn (Hattie, 2009). Growth-Mindset Teaching is meant to transmit growth-mindset principles from professor to student and thereby create a class environment that nurtures growth-mindset beliefs while students learn. Thus, we developed a GMST pedagogy where error is presented as a learning opportunity and participants can feel safe to learn, re-learn, and explore knowledge without the fear of being wrong (Dweck, 2008, 2012, 2016; Hattie, 2009). We integrated five elements as part of our GMST pedagogy to create a class environment that focuses on promoting growth-mindset beliefs in undergraduates. We'll elaborate on each of these five elements.

1. Use the class as a training room.

The first element of this teaching pedagogy is utilizing the class as a training room for students, a perspective that fosters a mindset of active striving to learn and progress. The classroom is a place where mistakes are opportunities, a place where students feel safe to learn, re-learn, and explore new knowledge without feeling pressured to be right (Hattie, 2009). Using the class for growth and training without penalizing failure will create a safe and secure environment for students that encourages them to invest more energy into learning and raising their intelligence, which will help them develop growth-mindset beliefs (Dweck, 2016). By treating the classroom as a training area, professors are able to build a classroom culture of thinking (O'Brien, Makar, Fielding-Wells, & Hillman, 2015) and provide students with the support they need to develop growth-mindset beliefs (Dweck, 2008, 2016). In other words, professors will use class inquiries as an apprenticeship that develops ways of thinking (Cobb, Wood, & Yackel, 1993). However, professors need to assess their students (Rissanen, Kuusisto, Tuominen, & Tirri, 2019) to obtain a better understanding of their students' current mindsets so that they can then plan accordingly.

With one of the core features of the growth-mindset pedagogy being focused on process (Dweck, 2008, 2016), professors must communicate to students that class time is meant for constructive criticism and that student participation during class is key to their knowledge growth (Rissanen et al., 2019) as well as to their development of growth-mindset beliefs. Otherwise, this GMST pedagogy will not produce positive effects. Thus, classroom settings need to be open and inviting if students are to feel welcome and not feel intense pressure to succeed, which can be debilitating. The willingness to take intellectual

risks is developed through a classroom culture that promotes risk-taking (Allmond, Hillman, Huntly, Makar, & O'Brien, 2016). Overall, the classroom needs to be a space where failure is allowed and encouraged.

2. Require students to submit homework and assignments prior to class to increase in-class engagement and discussion quality.

The second element of a GMST pedagogy is requiring students to submit their homework and assignments before class time. This will help provide better in-class participation, discussion, and comprehension. Unlike lecture style teaching where homework is assigned after learning a particular concept during class, in GMST pedagogy, students are given assignments on marketing concepts before learning about them in class. Previous studies show that collaborative discussions generate higher interest and engagement among participants (Wu, Anderson, Nguyen-Jahiel, & Miller, 2013). Thus, by completing assignments before class and gaining a prior understanding of the concepts and topics to be covered, students will be better prepared to interact with professors and peers during class discussions. This early preparation for class will enable students and professors to engage in collaborative discussions and enable professors to successfully utilize the class as a training room, which supports our first GMST element. Individuals feel more committed to collaboration when the organization they are part of empowers them to do so (Hanaysha, 2016), and by setting assignment deadlines prior to rather than after class, professors are instilling in their students the feeling of academic empowerment.

3. Provide weekly feedback on students' performance and suggestions on how their work might be improved.

The third element of this teaching pedagogy is the provision of continuous feedback on a weekly basis that assesses students' performance and offers suggestions on how they might improve it. Providing feedback to students shortly after an assignment or exam enables them to recall the graded experience in greater detail, which results in more positive and confident responses (Reynolds, 2013). Feedback that assesses progress encourages students to take intellectual risks, which is key to improvement (Allmond, Hillman, Huntly, Makar, & O'Brien, 2016; Hattie, 2009). Overall, the main purpose of feedback is to help students learn and improve their performance, i.e., to help them close the gap between their current knowledge and where they want to be (Hattie, 2009). Frequent feedback instills a growth-mindset in students because it immediately reinforces the idea that they can continue improving (Reynolds, 2013). Students with fixed-mindset beliefs will attribute an academic failure to a lack of ability on their end; however, an instructor can prevent that self-assessment from surfacing by providing immediate feedback and explaining that feedback is intended to provide students with ways to improve on future assignments (Allmond et al., 2016). Thus, feedback frequency is equally as important as the feedback itself when trying to help students develop growth-mindset beliefs.

Feedback is one of the most vital practices for facilitating growth in students because it enables them to evaluate their own learning (Allmond et al., 2016; Ferguson, 2011; Hattie, 2009). However, professors must ensure their feedback is positive, or at least neutral, as predominately negative feedback will discourage students, and discouragement leads to weakened effort and encourages the adoption of fixed-mindset beliefs (Hattie & Timperley, 2007). The language used when providing feedback can also push students toward one mindset versus another (growth vs. fixed). If a professor tells students they are "good at" a particular task, they are using language that could instill fixed-mindset beliefs, as comments like this allow students to believe that their skills have always been good. To use language that fosters growth-mindset beliefs in students, it is important to reward the process and not just results (Dweck, 2016). Comments on the effort that produced a result are more meaningful and reinforce growth-mindset beliefs that instill in

students the conviction that they can improve their skills (Briggs, 2019).

4. Allow students to experience some failure without being penalized.

Learning always involves failure. However, students with low tolerance for failure are often unable to persist in the face of difficulties (Allmond et al., 2016). Thus, to instill growth-mindset beliefs in students, professors must change the way they view failure and be alert to ways they inadvertently promote it in their courses. Professors should help students focus on personal progress and reflect on their errors (Arroyo et al., 2016). Very often grading is used as a tool to separate good students from the bad, a practice that encourages the adoption of fixed-mindset beliefs across a range of students (Orlando, 2011). This is the reason why the fourth element of our GMST pedagogy is to allow students to fail occasionally without penalty.

Academic failure creates anxiety in students (Hattie, 2009). They are evaluated at several points throughout the semester, and each time the evaluation is understood as a measure of success. Students' final grades are a combination of all these checkpoints, meaning failure is something that a student carries throughout the course. More often than not in undergraduate level courses, students will fail an exam early on, and even though they have mastered the material by the end of the course, that one failure hinders them from getting a final grade that reflects their mastery (Miller, 2015). As a result, students try to avoid failure at all costs; they do whatever it takes to get a desired grade rather than do what it takes to learn the material (Orlando, 2011). Thus, to relieve the pressure attendant on failure and place the focus back on learning, we decided to allow students to fail on occasion throughout the semester without affecting their final grade. Too often, grading is an obstacle preventing students from truly focusing on learning and flourishing in the classroom.

5. Provide students with multiple opportunities to improve their performance.

The fifth element of this teaching pedagogy is providing students with multiple opportunities to improve their performance. Professors must foster an environment where students can focus on feedback, reflect on their deficiencies (Arroyo et al., 2016), and submit additional attempts to improve their work (Hattie, 2009). Without reinforcement and the ability to apply feedback, neither students nor professors will be able to measure feedback's effectiveness (Boud, 2000). Ultimately, students learn by reflecting on their deficiencies and addressing them. When professors return a graded assignment with comments on how to improve it and allow students to resubmit, they offer their students an opportunity to experience genuine learning by reflecting on the assignment's problems and addressing them (Orlando, 2011). Not taking advantage of this opportunity is a mistake on the professor's part, as allowing students to rework previously submitted assignments forces them to embrace the learning process and apply the feedback (Sackstein, 2016).

Very few people master a topic on their first encounter with it, so why do we expect students to master a topic on their first encounter with it? By distributing finalized grades on exams and other one-time assignments, we instill fixed-mindset beliefs among students, making them think there is no way to improve their grades. These practices do not provide students with the opportunity to master concepts in ways consistent with how humans naturally learn. Instead, time constraints combined with a fear of failure push students toward memorization and cramming rather than active learning that lasts. Education is not about compliance or a game of memorization and task completion. These are byproducts of fixed-mindset induced learning. Thus, to provide a rich learning experience and promote growth-mindset beliefs, professors must allow students multiple opportunities for improvement (Sackstein, 2016), a practice that supports the fourth GMST element.

If universities are serious about developing 21st century skills, then

creating a classroom culture that creates an environment that can promote the development of these skills appears to be critical. Next, we elaborate on what we consider the most important GMST implications for students.

2.4. GMST implications among undergraduate students

Research on mindset theory has spread through different populations (Healy, 2017), and findings from the classroom have been among the most profound (Healy, 2017). Although research on mindset theory has never been linked to a particular age, mindsets can be especially influential during adolescent years when the brain is still developing (Sisk et al., 2018). During this time, what students believe about how intelligent they are and whether their intelligence can be raised can have significant effects on their learning ability in the classroom. Students who have growth-mindset beliefs will see obstacles in the classroom as opportunities to learn, whereas students with fixed-mindset beliefs will see them as insurmountable barriers (Sisk et al., 2018). Their mindset will determine the type of academic goals they set for themselves and the level of effort they put into pursuing them (Mahmud, 2017).

Professors play an important role in instilling growth-mindset beliefs in undergraduates when they provide feedback that helps students develop growth-mindset beliefs rather than fixed-mindset ones. Research shows that teaching approaches based on praising students for their effort tend to stimulate development of growth-mindset beliefs, whereas praising students for their achieved results tends to stimulate fixed-mindset beliefs (Dweck, 2000, 2007). Thus, when professors praise students on achieved results, they reinforce fixed-mindset beliefs by implying that students are naturally good in that subject. If students believe they are good in a subject, they will naturally find comfort in that area and limit themselves to it (Mahmud, 2017). However, when professors praise students for their effort, students understand their effort as something positive and will be more inclined to face the more challenging situations that will help them develop growth-mindset beliefs.

Overall, this GMST pedagogy should not be viewed as authority to lower standards and reward subpar rather than excellent work. Rather, this pedagogy encourages students to increase their efforts to learn and improve with each attempt regardless of the result. If praise is reserved only for perfection, students that continually miss the mark will be conditioned to believe they can never meet it, which could strengthen their fixed-mindset beliefs (Dweck, 2000, 2007).

Growth-mindset feedback is comprised typically of constructive responses from teacher to student. This feedback aims to help students improve performance and academic behaviors (Cutumisu, 2019), as well as enhance persistence and effort. In a study conducted to analyze the effect of growth-mindset feedback on writing motivation, it was found that objective feedback had a positive impact on motivation (Truax, 2017). Similarly, growth-mindset feedback combined with objective compliments generates progress on the development of growth-mindset beliefs (Truax, 2017).

Praising students for their efforts and providing continuous feedback consistent with growth-mindset feedback guidelines has been shown to drive significant change in the test scores of introductory programming students (Cutts, Cutts, Draper, O'Donnell, & Saffrey, 2010). The combination of teaching students about mindsets and providing constant growth-mindset feedback to students resulted in improved test scores at the end of the year (Cutts et al., 2010).

Therefore, it is proposed:

P1. It is possible to develop a growth-mindset teaching pedagogy for higher education that helps students develop or improve their growth-mindset beliefs.

Thus, we hypothesized

H1a: Undergraduate students, after being exposed to the GMST pedagogy over one semester, show an increase on growth-mindset

beliefs.

H1b: Undergraduate students, after being exposed to the GMST pedagogy over one semester, show a decrease on fixed-mindset beliefs.

3. Data and methods

A pretest-posttest control group design analysis was employed (Campbell & Stanley, 1971) for this research. Data collection took place during five semesters (Spring 2017–Spring 2019) among 31 different sections of Marketing Management and Principles of Marketing, both undergraduate courses. A total of 17 sections applying GMST pedagogy involving 867 participants were studied to capture the effect of GMST on the growth-mindset and fixed-mindset beliefs among students. The other 14 sections used lecture-style teaching and had 616 participants as a control group.

3.1. Research design

A self-administered questionnaire containing 31 items was utilized to capture data from students in their usual class environment. Although, this research relied on self-reported measures, these measures have been shown to be highly consistent with objective measures in many settings (Chen, Gillenson, & Sherrell, 2002). The study is an independent groups design with repeated measures.

Professors utilizing GMST pedagogy taught their students using the following elements: 1) used class as a training room, 2) required students to submit homework and assignments prior to class start, 3) provided weekly feedback on students' performance that included suggestions how to improve it, 4) allowed students to fail occasionally without penalty, and 5) provided students with multiple opportunities to improve their performance. Students in the control group were taught using traditional lecture-style teaching. Students' growth-mindset and fixed-mindset beliefs were captured at the beginning and at the end of the semester in both learning environments (GMST and lecture-style teaching). We hypothesized that students being taught with GMST pedagogy would show an increase in their growth-mindset beliefs and a decrease in their fixed-mindset beliefs after being exposed for one semester to GMST compared to the lecture style teaching conditions.

3.2. Sampling methodology and sample demographics

For hypotheses testing, 1483 undergraduate students willing to participate were selected using non-random sampling. The two courses from which participants were selected complied with the following criteria: 1) courses had to be part of the student's major or minor, 2) one had to be an intro-level course (2000 level) and the other a capstone course (4000), and 3) both courses had to have sections taught using GMST pedagogy and lecture-style teaching during the same semester. All participants belonged to 31 sections of Principles of Marketing (MKT-2110) and Marketing Management (MKT-4400) combined. Sixty-one percent of the participants were in the Principles of Marketing sections and 39% were in the Marketing Management sections; 59% were in a growth-mindset learning environment and 41% were in a lecture-style teaching environment; 46% were men and 54% women; 33% were employed and 67% were not employed; and 100% were full-time students.

3.3. Administration and plan of analysis

The same surveys were administered and collected by the researchers twice each semester, during the 2nd and 16th weeks of class. Information collected during the second week of class served as pretest data and information collected at the end of the semester served as posttest data. For the purposes of refining the items used to measure the constructs in this research, all items were verified using exploratory factor analysis (EFA) with maximum likelihood to ensure construct

reliability and validity prior to hypotheses testing. This process reduces the risk of utilizing inappropriate measures during hypotheses testing and misleading results. Because ANOVA is a preferred statistical method for experimental research designs (Kerlinger & Lee, 2000), statistical evaluation of the data was performed using factorial ANOVA to detect significant main effects and interactions on each of the variables (growth-mindset and fixed-mindset) for hypotheses testing. The analyses employed Bonferroni adjustments to compare the means of cells of relevant factors to eliminate concerns surrounding Type I and II error rates frequency and factorial designs (Smith, Levine, Lachlan, & Feduik, 2002). All statistical analysis was performed using SPSS 25.0 software.

3.4. Measures, construct reliability, and sampling adequacy

Growth-mindset and fixed-mindset constructs were measured using 25 items. Twelve were used to measure growth-mindset and 13 to measure fixed-mindset. Twenty items were adopted from the literature (Dweck, 2008, 2008a); however, the wording in all the items was modified to fit higher education settings. Although the adapted items have been validated in previous research, five new items were added to fully satisfy our research purposes. All items were measured using a seven-point Likert scale anchored between "strongly disagree" (1) and "strongly agree" (7). Additionally, six more items were included to capture some of the participants' demographic characteristics.

Both constructs showed appropriate reliability, as attested to by their Cronbach's alpha, 0.827 for the growth-mindset and 0.860 for the fixed-mindset (Hair, Black, Babin, & Anderson, 2010). Constructs exhibited discriminant validity by having larger average variance explain estimates than the corresponding squared inter-construct correlation estimates (see Table 1) (Fornell & Larcker, 1981; Hair et al., 2010). Finally, measures of sampling adequacy (MSA) ranging from 0.862 to 0.956 indicated that data was suitable for factor analysis (Cerny & Kaiser, 1977).

4. Results

Linear regression analyses were used to determine the amount of variance in the system that could be attributed to the variables GMST, survey type, sex, and employment status. All variables were dummy-coded (0, 1) for linear regression because each of these variables is categorical rather than ordinal. Results of the linear regression analysis for the growth-mindset scale indicated that the four independent variables included in our model improved the fit, $F(4, 1120) = 3.045$, p = .016. However, they accounted for just 1.1% of the variance in this system. Furthermore, this analysis indicated that GMST and survey type are the only two significant predictor variables.

4.1. GMST development

The first research question addressed the development of a teaching pedagogy that could help students develop and/or increase their growth-mindset beliefs. The corrected model (indicating that the analysis focused on the mean of all groups, not a mean of zero) showed a p-value of .067, which is larger than 0.05. Thus, this model did not show a significant difference between scores for the group means ignoring independent variables. However, the results of the factorial ANOVA

Table 1
Correlation matrix (N = 1483) growth-mindset and fixed-mindset.

Construct	1	2
1. Growth-mindset	.827[a]/.645 [b]	
2. Fixed-mindset	-.486**	.860 [a]/.637 [b]

*p < .05, **p < .01 (2-tailed).
[a] Cronbach's Alpha.
[b] √AVE (square root of average variance explained).

yielded statistically significant differences between group means for teaching pedagogy (GMST and lecture-style teaching), $F(1, 1109) =$ 4.967, $p = .026$ ($r = 0.07$) and marginally significant differences between group means for survey type (1st vs. 2nd), $F(1, 1109) = 2.797$, $p = .095$ ($r = 0.05$). Thus, we found that the teaching pedagogy used resulted in a statistically significant difference between the two teaching styles (GMST and lecture-style teaching), whereas the difference in the two surveys (pretest and posttest) was only marginally significant. Participants' sex did not have an impact since the p-value was .435. Likewise, a student's employment status did not produce a statistically significant difference in means. When the interactions were analyzed, results yielded statistically significant differences between group means for the GMST and sex interaction, $F(1, 1109) = 3.668$, $p = .056$ ($r = 0.06$). The rest of the interactions were not significant, indicating no differential effects for other combinations of the four independent variables. See Table 2 for details.

4.2. Efficacy of the GMST

The second research question addressed the impact on growth-mindset and fixed-mindset beliefs among students after exposure to GMST pedagogy during one semester in one course.

The impact on growth-mindset beliefs resulting from the factorial ANOVA showed a significant main effect of GMST, $F(1, 667) = 8.500$, $p = .004$ ($r = 0.11$). Thus, we found a statistically significant difference on growth-mindset beliefs among students between the two teaching pedagogies (GMST and lecture-style teaching), as measured from the GMST ($M = 5.4034$, SD $= 0.76706$) and lecture-style teaching ($M = 5.2170$, SD $= 0.76418$). This is a 0.1864 difference.

There was also a significant main effect on fixed-mindset beliefs among students resulting from the factorial ANOVA of GMST, $F(1, 665) = 8.412$, $p = .004$ ($r = 0.11$). Thus, we found a statistically significant difference on fixed-mindset beliefs among students between the two teaching pedagogies (GMST and lecture-style teaching), as measured from the GMST ($M = 3.5728$, SD $= 0.92147$) and lecture-style teaching ($M = 3.6973$, SD $= 0.85280$). This is a 0.1245 negative difference.

Overall, these results indicate that GMST indeed helps develop or increases growth-mindset beliefs and reduces fixed-mindset beliefs among students compared to lecture-style teaching. Thus, hypothesis H1a and H1b are supported.

5. Discussion

Universities seeking to develop and/or improve growth-mindset

beliefs among their undergraduate students are concerned about how different teaching pedagogies impact students' mindset. For this reason, learning more about the effect that the suggested GMST pedagogy has on growth-mindset and fixed-mindset beliefs is paramount. Most growth-mindset studies investigated the effect of short-term interventions only. We investigated the effect of growth-mindset interventions in students by incorporating these interventions into the teaching pedagogy used by professors for one full semester.

For this study, we first analyzed the possibility of creating a teaching pedagogy that can help undergraduates develop and/or increase their growth-mindset beliefs. Second, we analyzed the efficacy of this GMST pedagogy in the development of and/or the increase of growth-mindset beliefs as well as the reduction of fixed-mindset beliefs among students compared to lecture-style teaching. We found that by incorporating five elements into the teaching pedagogy during one semester, 1) using class time as a training room, 2) requiring students to submit homework and assignments prior to class start, 3) providing weekly feedback on students' performance and suggestions on how to improve it, 4) allowing students to fail occasionally without being penalized, and 5) providing students with multiple opportunities to improve their performance), students improved their growth-mindset and reduced their fixed-mindset beliefs. Moreover, this GMST pedagogy significantly improved growth-mindset beliefs by 3.44% and reduced fixed-mindset beliefs by 3.48% on average, compared to lecture-style teaching groups. We also discovered that the interaction between the GMST pedagogy and sex is important. On average, the increase of growth-mindset beliefs among female students exposed to the GMST pedagogy vs. lecture-style teaching was 5.75 times greater than the increase of growth-mindset beliefs among male students under the same conditions. Female growth-mindset beliefs difference on means was 0.1864, whereas male growth-mindset beliefs difference on means was only 0.0324.

This significant increment in growth-mindset beliefs and reduction on fixed-mindset beliefs suggests that the proposed GMST pedagogy is an effective teaching alternative for helping undergraduate students increase or further develop their growth-mindset beliefs. Although effectiveness of this pedagogy was studied in only two courses, the efficacy of this pedagogy illustrates the potential of scalability if implemented in multiple courses.

Finally, our results contribute to the growth-mindset field by offering an effective pedagogy that can be incorporated easily into higher education environments and has shown to have a positive effect on developing growth-mindset beliefs among undergraduates. In sum, these results support our view that when using the appropriate teaching pedagogy, professors can help undergraduate students increase and/or develop their growth-mindset beliefs. Furthermore, there is a significant difference in the growth-mindset effect between the GMST pedagogy and lecture-style teaching.

6. Conclusion

Professors can help students develop their growth-mindset beliefs and reduce their fixed-mindset beliefs by incorporating the following five elements in their teaching pedagogy: 1) using class as a training room, 2) requiring students to submit homework and assignments prior to class start, 3) providing weekly feedback on students' performance that includes suggestions on how to improve their performance 4) allowing students to occasionally fail without being penalized, and 5) providing students with multiple opportunities to improve their performance. However, depending on how this GMST pedagogy is implemented, incremental increases in growth-mindset beliefs among students could range from 0.5% to 4% after being exposed for one semester in one class. At the same time, fixed-mindset beliefs could be reduced from 0.5% to 4%. This study complements other research (Rissanen et al., 2019) and highlights the fact that this GMST pedagogy offers a potential solution to the demand for efficient, low cost, and easy

Table 2
Factorial ANOVA (4-way): Growth-mindset.

Dependent Variable: Growth-Mindset	All Courses (2000 and 4000)	
	Mean Square	F-Value
Corrected Model	.891[a]	1.599
Intercept	26156.625***	46950.235
GMST	2.767**	4.967
Survey Type	1.558[a]	2.797
Sex	.340	.610
Employed	.064	.115
GMST[a] Survey Type	1.186	2.128
GMST[a] Sex	2.044**	3.668
GMST[a] Employed	.002	.004
Survey Type[a] Sex	.368	.660
Survey Type[a] Employed	.749	1.345
Sex[a] Employed	.142	.255
GMST[a] Survey Type[a] Sex	.077	.138
GMST[a] Survey Type[a] Employed	.056	.100
GMST[a] Sex[a] Employed	.903	1.621
Survey Type[a] Sex[a] Employed	.468	.840
GMST[a] Survey Type[a] Sex[a] Employed	1.065 E−5	.000

[a] p<.10,**p < .05,***p < .01.

to implement growth-mindset interventions in higher education.

More studies in this area are needed before recommending the best growth-mindset elements or interventions for GMST pedagogy for this and other student populations. However, professors interested in helping students develop and/or increase their growth-mindset beliefs could use the GMST pedagogy proposed in this research study.

7. Limitations and future research

The study indicates the potential efficacy of GMST as an aid for growth-mindset development and diminishing fixed-mindset beliefs among undergraduate students. There are, however, several limitations to this study. First, although we found a statistically significant difference, the size of the effect was relatively small. Second, we did not distinguish between the efficacy of the GMST pedagogy between 2000 level and 4000 level course-sections, and it may be that one is more effective at one level than the other. We chose only two business undergraduate courses to run the study. Both experimental and control groups used different professors among class-sections, which raises questions as to whether group differences may have arisen because of differences in how professors executed their teaching methodologies rather than the GMST pedagogy. However, we attempted to control for this effect by comparing the growth-mindset class interventions which were presented in all GMST sections. Neither participants nor courses and sections were randomly selected, which limits the generalizability of the results. Because participants were attending GMST classes relevant to their majors or minors, they arrived with an interest in the subject, which raises questions as to whether this pedagogy would be equally effective and the results the same in classes that students didn't wish to take or resented taking. Finally, participants were only students willing to be part of this study, which limits the possibility of estimating the non-response bias.

To compensate for the limitations of this research, we suggest future studies should have the same professor teaching some class sections using GMST and some using lecture-style teaching. This will help control for group differences due to professor's teaching style and personality (Hattie, 2009). We also encourage the use of random selection of participants within the class sections to improve results' generalizability. Researchers might also select courses that students are taking merely to fulfill their general education requirements (e.g., history), not because they are interested in the subject. Furthermore, applying statistical techniques to identify non-response bias are encouraged. If differences between initial and late respondents on key metrics are determined, we conclude that we may have non-response bias in our study and that we could use those differences as a proxy for non-response bias (Berg, 2005).

Finally, conducting longitudinal studies to determine if growth-mindset beliefs continue improving after being re-exposed to GMST as well as testing new applications of GMST outside of higher education are also encouraged. Last, exploration to determine why female undergraduate students were more receptive to GMST than male students is needed.

CRediT authorship contribution statement

Miguel A. Sahagun: Conceptualization, Methodology, Formal analysis, Project administration, Supervision, Software, Validation, Writing – original draft. **Randy Moser:** Conceptualization, Data curation, Writing – review & editing. **Joseph Shomaker:** Writing – original literature review, review & editing. **Jenna Fortier:** Writing – original literature review, review & editing.

Declaration of competing interest

Authors have no competing interests to declare.

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