NONTRADITIONAL DOCTORAL STUDENTS' PERCEPTIONS OF INSTRUCTIONAL STRATEGIES USED TO ENHANCE STATISTICS SELF-EFFICACY IN ONLINE LEARNING

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ABSTRACT

Self-efficacy is defined as people's perceptions of their abilities to organize cognitive, social, emotional, and behavioral skills and their decisions on how much effort to use to attempt the action. This exploratory sequential, mixed-methods study examined nontraditional doctoral students' perceptions on how instructional strategies helped with their self-efficacy in online statistics learning as aligned with four sources of self-efficacy (i.e., mastery experiences, vicarious experiences, verbal persuasion, and physiological reactions). The relationship between the instructional strategy used and the students' statistics self-efficacy was examined. The effective instructional strategies are discussed and recommendations provided for online statistics instructors and course designers.

Keywords: *online teaching, self-efficacy, instructional strategy, nontraditional students*

Bandura (1982, 1994a, 1997) defined self-efficacy as people's perceptions of their abilities to organize cognitive, social, emotional, and behavioral skills and subsequently their decision on what they can do and how much effort to put into the action. The concept of self-efficacy emphasizes people's beliefs, rather than their actual capabilities, and how these determine how they feel, think, behave, and motivate themselves to bring changes to their lives through cognitive, motivational, affective, and selection processes. People with a strong sense of self-efficacy approach difficult tasks with strong intrinsic motivation and thus they set goals for themselves, make the commitment, face failures with positivity, and believe they can exercise control over setbacks. They are more likely to maintain a healthy well-being with well-rounded experiences and to accomplish goals in the real world.

Extensive research has been done on how to foster one's self-efficacy from the developmental perspective (Bandura, 1994b; Wigfield & Eccles, 2002). In the educational setting, self-efficacy is related to students' learning outcomes, value, self-regulation, metacognition, locus of control, intrinsic motivation, and learning strategy use (Bartimote-Aufflick et al., 2016). It has been proposed that students' self-efficacy and academic performance can also be improved through the appropriate use of instructional strategies targeting students' perceived sense of autonomous learning (Ginings & Ponton, 2017; Huang & Mayer, 2019). This becomes particularly important in online teaching as instructors often find it challenging to motivate students, especially in teaching research tool courses (e.g., statistics) online (Larwin & Larwin, 2011; Lu & Lemonde, 2013; Saadati et al., 2015; Sosa et al., 2011). Students' apprehension towards

statistics (Macher, et al., 2013; Onwuegbuzie & Daley, 1999; Onwuegbuzie & Wilson, 2003) makes online statistics teaching and learning least attractive for both the instructor and students.

Using an exploratory sequential, mixed-methods approach, we focused on the adult, nontraditional students who take the introductory online statistics course in the Educational Leadership doctoral program at a public comprehensive, four-year university. The Association of Nontraditional Students in Higher Education (ANSHE) defines nontraditional as students who pursue a higher degree while working full time or returning to school after a significant interruption. Similar definitions by the U.S. Department of Education (NCES, n.d.) consider nontraditional students to be independent for financial aid purposes, have one or more dependents, be a single caregiver, delay postsecondary enrollment, or attend school part time. Out of the total enrollment of 19.9 million students who attended colleges and universities (including both undergraduates and graduates), 7.5 million learners (37.69%) were nontraditional students and were 25 years and older (NCES, 2019).

The purpose of this exploratory sequential, mixed-methods study was twofold. The first phase of this study was a qualitative exploration of nontraditional students' perceptions of how self-efficacy in statistics learning could be enhanced through the instructional strategies utilized in a doctoral-level introductory online statistics course. The phenomenon of the study was the research-based instructional strategies that are aligned with the four sources of self-efficacy (Bandura, 1982, 1994a, 1997). The qualitative data were collected via a questionnaire with open-ended questions. Secondly, we quantitatively assessed the participants' self-reported self-efficacy and anxiety in learning statistics online. A domain-specific self-efficacy measure and a self-efficacy measure targeting nontraditional students' autonomous learning were used to assess participants' statistics self-efficacy. The first phase qualitative data and second phase quantitative data were combined to find out how varied instructional strategies could help with students' statistics self-efficacy online (Creswell & Plano Clark, 2018).

The following research questions were addressed in this study:

Qualitative RQ1: What are the nontraditional students' perceptions of the instructional strategies utilized in the doctoral-level introductory online statistics course, and how do the instructional strategies help with their online statistics learning?

Quantitative RQ2: What is the nontraditional students' self-reported self-efficacy after taking the doctoral-level introductory online statistics course and their statistics anxiety? Is there any relationship between students' use of the instructional strategies, self-efficacy, and anxiety in learning statistics online?

THEORETICAL FRAMEWORKS

Theory of Self-Efficacy

Self-efficacy beliefs are a fundamental component of Albert Bandura's social cognitive theory (1982). Bandura defined self-efficacy as people's beliefs about their capabilities to produce at a designated level and such beliefs become a crucial motivational factor in determining how people feel, think, and behave (Bandura, 1997). The self-efficacy theory provides a framework for analyzing human ideas, motivation, inspiration, and action. In education, self-efficacy beliefs have both direct and indirect effects on individuals' interests, task performance, and academic outcomes. Baltimote-Aufflick et al. (2016) reviewed 64 articles published since 2000 and found a strong association between self-efficacy and student learning outcomes, suggesting that self-efficacy of college students varies across different conditions and self-efficacy depends on motivation, cognition, and regulation factors.

Bandura (1982, 1994a, 1997) proposed that mastery experiences, vicarious experiences, verbal persuasion, and physiological reactions are the four primary sources of self-efficacy. Performance accomplishments refer to the past successful experiences a student has had after performing a task. Enactive mastery experiences and performance accomplishments are the most significant sources of efficacy information as they deliver the maximum reliable evidence of whether one can assemble whatever it takes to succeed (Bandura,1997; Schunk & DiBenedetto, 2016). Vicarious experience refers to the process of one observing a role model performing a task successfully. Going beyond the

ranges of others' performances helps develop self-efficacy while failing to meet the performance of others depresses it. This kind of social observation is predominantly valuable in developing one's self-efficacy beliefs (Bandura, 1994a; Schunk et al., 1987). Verbal persuasions encourage and motivate students with meaningful and accurate feedback. Persuaders are efficient and skilled individuals who build and develop students' self-efficacy beliefs by measuring their success through self-improvement instead of achievements over others (Bandura, 1997). Furthermore, physiological and emotional reactions stimulate self-efficacy beliefs in students where success is anticipated. While weak performances happen due to high arousals such as stress and anxiety, increased awareness can facilitate the usage of skills, and performance can be achieved with mild arousals (Usher & Pajares, 2008). Those four primary sources of self-efficacy are discussed in the literature review below on how they have been applied to designing online courses (e.g., Huang & Mayer, 2019).

LITERATURE REVIEW

Factors Related to Self-efficacy

Self-efficacy is how people perceive their abilities to organize cognitive, social, emotional, and behavioral skills when accomplishing tasks (Bandura, 1982, 1994a, 1997). Self-efficacy is the basis of human performance and decides what people can do and how much effort they give to attempt the action (Peterson & Arnn, 2005). Motivation, cognition, and regulation factors are the major areas where students' self-efficacy can be enhanced to help with academic success and satisfaction (Baltimote-Aufflick et al., 2016). Overall et al.'s (2011) study showed that doctoral students with a high level of autonomy when receiving academic support (e.g., providing timely feedback on academic activities to help with student progress) reported higher self-efficacy in doing research. Along the same line, Duchatelet and Donche (2018) proposed that autonomy-supportive teacher behavior (e.g., allowing students to make their own choices) could enhance self-efficacy for students who are more autonomously motivated compared to their amotivated counterparts.

Van Dinther et al. (2011) reviewed 39 empirical studies and found that the interventions that incorporate enactive mastery experiences are the most powerful source of creating a strong sense of efficacy. Practical experiences could enhance students' self-efficacy when students apply knowledge and skills in performing tasks. Other means of raising students' self-efficacy include setting reasonable learning goals, providing instructor demonstrations and proper learning resources, using simulations, and fostering an unstressed learning environment (Koh & Frick, 2009; Tompson & Dass, 2000). Baltimote-Aufflick et al. (2016) found self-efficacy to be strongly associated with students' academic achievements, self-regulation, motivation, and strategy use. Improved self-efficacy is evident when video presentation (Adams, 2004), remedial learning (Chen, 2011), topic-specific DVD lectures (Govaere et al., 2012), and responsive virtual learning agents (Kim et al., 2007), are used.

Statistics Anxiety

Students' self-efficacy beliefs are related to academic performance; thus it deserves more research attention in the challenging subjects in academic learning. The subject of statistics at the university level is quite challenging to deliver and it has long been acknowledged that statistics courses are the most anxiety inducing courses in students' perceptions (Macher, et al., 2013; Onwuegbuzie & Daley, 1999; Onwuegbuzie, & Wilson, 2003), particularly among female and minority graduate students (Zeidner, 1991). Past research suggests that a high level of statistics anxiety in students leads to minimum effort for learning (Onwuegbuzie, 2004). A higher degree of self-efficacy in statistics learning could only be achieved with less anxiety and more favorable attitudes towards statistics (Perepiczka, et al., 2011). There is a direct negative influence of anxiety on students' self-efficacy in statistics learning and an indirect negative impact on statistics performance (Hoegler & Nelson, 2018).

With the increased popularity of distance education, more statistics courses are being offered online, and statistics anxiety has been amplified (Larwin & Larwin, 2011; Lu & Lemonde, 2013; Saadati, et al., 2015; Sosa et al., 2011). Mathematical and statistical content, when presented in the online environment, increase learner anxiety that consumes cognitive resources thus hindering learning (Dowker et al., 2016; Maloney & Beilock, 2012). Thus, it is important to research effective strategies that foster students' self-efficacy in learning statistics online.

Fostering Self-efficacy in Online Learning

Hodges (2008) argued that self-efficacy beliefs may develop differently in online environments compared to more traditional, face-to-face environments. Mastery experiences (Bandura, 1982) in online environments could be achieved by using a sequenced and clustered online course design, where small chunks of low-level skills create opportunities for students to experience early successes before tackling more complex materials, thus boosting their self-efficacy. Pedagogical agents for learning could be used to boost self-efficacy via vicarious experiences. Further strategies to foster self-efficacy in online environments include email communication and written encouragement (Jackson, 2002), precourse evaluations (Songsore & White, 2018), audio feedback (Ice et al., 2007), and online discussions (Everson & Garfield, 2008) to build students' self-efficacy via verbal persuasion and affective states. Furthermore, the instructor can boost students' self-efficacy through quality two-way communications and support with technology skills (MacDonald & Thompson, 2005). For example, self-introduction videos could allow students to get to know about the online course at the beginning to enhance the students' knowledge about the programs and tools, encourage synchronous and asynchronous interactions, and make a strong social presence (Jiang, et al., 2019; Yang, 2017).

Huang and Mayer (2019) showcased a framework of example-based online statistic instructional strategies that systematically target all four sources of self-efficacy (Bandura, 1997). Trafton and Reiser (1993) reported the most effective approach to acquiring a new skill is to present an example, then immediately solve a similar problem. Self-efficacy could be developed by using a virtual pedagogical agent in a mastery model to exhibit a problem-solving process at the expert level or a coping model to overcome the early mistakes and complications and gradually show progress to reach the mastery level (Veletsianso, 2010). Implementing expert modeling and peer modeling through pedagogical agents was found to be advantageous over typical course examples (Huang, 2017; Huang & Mayer, 2019). The use of an online animated educational agent to verbalize and demonstrate the correct procedure of solving problems to achieve mastery experience is encouraging.

The mental practice was well-recognized to help with students' learning (Cooper et al., 2001). Mentally practicing an example process acts as a mastery aid that scaffolds students learning and produces a sense of accomplishment. Huang and Mayer (2019) found that a performance-oriented strategy with clear guidance could enable a successful performance and develop self-efficacy beliefs among students. Furthermore, social persuasion was achieved in online statistics learning via attributional feedback (Huang & Mayer, 2019). Students' self-efficacy perceptions strengthen when others express belief in their capabilities by providing effort attributional feedbacks (Dweck, 2008). The fourth feature of self-efficacy, physiological and affective state, was also found to be critical in online statistics learning via math anxiety coping messages (Huang & Mayer, 2019). When an animated pedagogical agent was created to deliver an anxiety-coping message verbally in a video, students' anxiety in statistics learning greatly reduced and their performance improved (Huang & Mayer, 2019).

Summary

Past research explored the statistics anxiety problems and evidence shows that students' self-efficacy in learning statistics online could be boosted if the four sources of self-efficacy are incorporated in the course design. However, it was unclear how such sources could be made readily available in teaching statistics online without a major, costly course makeover (i.e., creating pedagogical animations for all course tasks), particularly in working with adult, nontraditional students. The current exploratory sequential, mixed-methods study used adult, nontraditional students to explore their perceptions of the instructional strategies in a doctoral-level online statistics course. Our goals were to identify the instructional strategies boosting nontraditional students' statistics self-efficacy and to examine the relationship between the strategy usage and their self-reported self-efficacy and anxiety. The study findings could help make useful recommendations to online educators and course designers to reduce student anxiety, increase self-efficacy, and improve performance outcomes in learning statistics online.

METHOD

Qualitative Research: The Role of the Researchers

Qualitative researchers are interested in "understanding how people interpret their experiences and

how they construct their worlds and what meaning they attribute to their experiences" (Merriam & Tisdell, 2016, p. 6). Thus, qualitative researchers do not predict outcomes; instead, they seek to make meaning from people's experiences within the world. The qualitative researcher serves as the primary instrument for data collection and analysis. There are advantages and disadvantages to this positioning. A positive side is the researcher can clarify and summarize the data and check with the participants for accuracy (Merriam & Tisell, 2016). However, a disadvantage of this human instrument is that bias may occur that can negatively impact the study. The researcher must identify the biases and values they hold and reveal how they may be shaping the collection and interpretation of the data (Merriam & Tisdell, 2016).

The researchers' positionality and social identity are critical to understanding their role in every research stage. Carl and Ravitch (2021) defined positionality as "how the researcher's role and identity intersect in the relationship to the context and setting of the research" (p. 10). Furthermore, "positionality consists of multiple roles and relationships between the research and the participants within and related to the research setting, topic, and broader contexts that shape it" (p. 10).

Reflexivity

The first author of this study is the course lead and instructor of the doctoral-level introductory course. In this study, to avoid potential impact, voluntary, antonyms, indirect data collection (i.e., an online survey) was used to gather authentic information from the participants. Also, the study invitation was sent out after the course and grading are completed to avoid any conflict of interests. Additionally, the provisional coding method was used in data analysis to avoid subjective perspectives.

The second author teaches most of the core research courses except statistics in the Department of Educational Leadership with the first author. The second author's expertise working with nontraditional students, along with the integrated nature of the research methods and the statistics courses, helped develop the data analysis and interpretations from a holistic, objective perspective.

Program Setting and Participants

In this study, the participants were students enrolled in a 100% online Education Leadership doctoral program at a four-year public, comprehensive university. The participants were adult, nontraditional students who work as full-time educators and administrators in the K–12 school system. All doctoral courses in this program are asynchronous online courses delivered through the D2L Brightspace learning management system. Nineteen students who completed the doctoral-level introductory statistics course in the 2020 Summer or Fall semesters were invited to participate in this study.

INSTRUMENTS

Qualitative Questionnaire with Open-ended Questions

Due to the 2021 COVID-19 restrictions, the researchers collected qualitative data through a questionnaire with eight open-ended questions on Qualtrics (see Appendix A). The content of the questions was based on the four domains of self-efficacy: vicarious experience, social persuasion, affective states, and mastery experience (Bandura, 2006; Huang & Mayer, 2019). Using this questionnaire, we gathered the participants' perceptions of whether and how the varied instructional strategies from the introductory statistics course helped with their online statistics learning. Participants were asked to reflect on their statistics courses learning experiences to answer questions such as, "In this online statistics course, which of these formats have helped you learn? (A) the PDF format VIDEO modeling examples with oral explanations or (B) the WORD document/book that provides worked examples? Please pick one and elaborate WHY with details." Participants were also asked whether additional good strategies could be used in this course.

Quantitative Measures

In this study, two self-efficacy measures were used to assess participants' self-efficacy after taking the doctoral-level introductory online statistics course. First, participants' confidence in performing the seven assignments of the course (see Appendix B) such as "I can use descriptive statistics in SPSS to understand data" (Bandura, 2006; Huang & Mayer, 2019) was measured on a 100-point rating scale (from 0 *no confidence at all* to 100 *extremely confident*). Bandura (2006) indicated there is no "one measure fits all" approach in measuring perceived self-efficacy. Self-efficacy

measure should be domain-specific in gradations of "can do" to measure participants' capabilities "as of now." Similar to Huang and Mayer (2019), seven specific domains in the doctoral-level introductory online statistics course were identified and the seven corresponding learning objectives were used to construct the self-efficacy measure. Participants' perceived self-efficacy on those seven tasks reflected their self-efficacy towards this course (Huang & Mayer, 2019).

Secondly, participants' self-efficacy was measured using the Appraisal of Learner Autonomy with permission (ALA; Ponton et al., 2005). Considering the nontraditional online students' characteristics in this study (Veletsianos, 2020), we used ALA to measure participants' perceptive self-efficacy using situational impediments applicable to adult life (e.g., "When I am feeling tired") to target the autonomous learning of adult learners. Based upon Bandura's (1997) guideline, ALA (see Appendix C) measures learners' self-efficacy to engage in autonomous learning from 0 *cannot do at all* to 100 *certainly can do* and has an internal consistency of $\alpha = .86$ (Ponton et al., 2005).

Additionally, participants' learning anxiety was measured on a 9-point rating scale (from 1 *not at all anxious* to 9 *extremely anxious*) for participants to self-report the amount of anxiety they experienced while taking the statistics online course. Participants' gender, age, and ethnicity were also collected.

DATA ANALYSES

Qualitative Data Analysis

To address Qualitative RQ1, content analysis (Grbich, 2012; Nagai, 2015) using the provisional coding approach (Saldaña, 2016) was done by the primary researcher to identify the instructional strategies that are relevant to students' self-efficacy. The instructional strategies identified in Huang and Mayer's (2019) study were used as the provisional guidance in coding.

Quantitative Data Analyses

To answer Quantitative RQ2, descriptive statistics, repeated-measures ANOVA, and independent samples *t*-test were used to assess students' self-reported self-efficacy after taking the online statistics course and the relationship between students' use of the instructional strategies, self-efficacy, and learning anxiety.

RESULTS

Description of the Sample

Ten students participated in the study with a response rate of 52.6%. Eight of them were female (80%) and two were male (20%) with an average age of 47.7 ($SD = 4.0$) and a range of 42 and 55. There were six participants (60%) who self-reported to be Caucasians, two (20%) African American, and two (20%) Hispanic.

Qualitative Research RQ1: Instructional Strategies in Learning Statistics Online

The first focus of the study was to find out students' perceptions about how the varied instructional strategies utilized in this introductory online statistics course have helped them learn statistics online. Participants were asked to reflect on their statistics learning experiences in this introductory online statistics course and provide responses to open-ended questions that are aligned with the four sources of self-efficacy.

Vicarious Experience: Live Modeling Examples

Between the step-by-step video modeling examples with oral explanations and the step-by-step Word document that provides worked examples on paper, eight out of ten participants considered the video format more effective. They reported, "I understand better when I have visual and auditory instructions. If I don't clearly understand one format, the other format often provides clarity." It is worth noting that the two participants who preferred the Word format reported that they faced tech issues that they either couldn't get the videos to play or the audio sound was not very good.

When asked about other possible formats of using modeled examples to help with their online statistics learning, participants offered a wide variety of constructive suggestions, such as using Edpuzzle where learners can pause the video to ask questions, or offering additional weekly Q&A sessions for live modeling from the instructor. One professor suggested, "model using the system in real-time where we're able to ask a question." Another student highly recognized the value of live modeling in the weekly Q&A sessions currently offered and mentioned,

> *The modeling and clarification provided in the Q and A sessions were very valuable, especially when I had looked over the material first and came prepared with*

questions. Having the sessions midweek to allow for this preview would be beneficial.

Given the complexity of the statistics subject, one participant highlighted the importance of using live modeling in showing students how to make decisions in statistics. The student stated: "things are not 'always' true or required in order to employ a certain approach. This was very unclear and difficult to discuss out as a beginner in stats." Thus, the live modeling could offer abundant interactive opportunities between the instructor and students to focus on teaching problem-solving skills. Modeling and facilitation is especially important at the initial stage of learning. One student said:

I think that instead of having a first assignment that students complete on their own, there should be an SPSS click sheet that walks students through a scenario. Students would take the data set and follow the click sheet step-by-step, with the steps explained. Students are not choosing variables, but following an exemplar to see how it is done well. THEN students would start choosing variables and creating scenarios on the second try.

Social Persuasion: Attributional Feedback

When asked what types of feedback they have received in the online statistics course, all ten participants reported that they received both ability feedback (i.e., you got x out of y points), as well as detailed, precise, encouraging effort attributional feedback. In the effort feedback, they were encouraged to "keep trying," "focus on what to learn," and "built confidence in the content and in taking risks applying it." One student stated,

The feedback that was the most helpful was the one-on-one feedback that explained precisely where I had gone wrong, or what I could have improved, and directions as to where I could find guidance on these issues in the reading. The reading for each segment is very lengthy. It becomes overwhelming to pinpoint exactly what I need to reread or review in order to revise assignments to expectation. This kind of precise feedback was invaluable.

Participants' responses show their ubiquitous preference for instructors' encouraging feedback that recognizes the efforts they made, precisely points out the mistakes, honestly reinitiates the requirement, and sets expectations for further improvement. One student even suggested the instructor identify common mistakes that all students make to help individual students succeed. Most students benefited from the encouraging effort feedback feeling their efforts were well-recognized by the instructor, thus becoming persuaded to make more efforts. One stated:

I was praised for the effort I made on assignments and I was given time to correct any misconceptions. This was incredibly beneficial in my learning. This provided me an opportunity to practice until I was able to really understand the material without the anxiety or fear of failure. It was a safe place to make mistakes and it made learning safe and collaborative. I was able to collaborate with my professor and my classmates.

Affective States: Explicit Messages

When asked about whether they received explicit messages or implicit messages, eight students (80%) perceived the messages as explicit, instead of implicit. Surprisingly, when asked to recite verbatim the explicit message they received from the instructor, they wrote down the following with confidence (see Table 1).

Table 1. The Explicit Verbatim Told by the Instructor in the Online Introductory Statistical Course (N=10)

Explicit Message Verbatim from the Instructor
"It takes practice to understand the terms and the concept of statistics."
"Statistics is like learning a new language, and takes time and practice to increase comfort levels."
"Many, many people struggle in the beginning, but that over time, I would improve. This was very true."
"More we practiced the better we would get and that in the next course everything would make more sense."
"We have grown as a class based on her observations of our work."
"Once you gain a better understanding you will be able to see the importance, understanding, and application to our future work."
"Failure was okay during the learning process."
"It's like learning a different language."

Such explicit, clear messages helped the students cope with apprehension and anxiety towards statistics they initially had, making them "not afraid to ask questions and seek clarification." Students found learning statistics possible and recognized that the instructor "did a good job to destigmatize statistics." One reported learning in a "true learning" environment as the instructor "created an environment through our zoom meetings that allowed you to ask questions without fear of being wrong." One student said,

> *I certainly felt encouraged that this was possible to learn and understand and to not be afraid, which was very helpful because statistics was the biggest barrier to me wanting to pursue a doctorate and now I feel very confident.*

While most participants specified that they prefer explicit messages that encouraged their growth in this statistics course, one student claimed to be performing well even without any encouraging explicit message, "I have not doubted my ability and I have performed well." Similarly, another student stated, "I have a lot of self-motivation so I don't need it to be successful, but it is nice."

In addition to the explicit messages, students identified a wide range of strategies, from course design to personal learning strategies, that could help them cope with statistics anxiety. From the course design perspective, students believed retaking quizzes and redoing assignments allowed them to correct misunderstanding as it took away the anxiety and reinforced fundamental concepts. It is "the best way to alleviate anxiety instead of being forced to continue with imperfect understanding." Participants also discussed personal learning strategies that helped them cope with learning anxiety, such as using positive self-talk that "I am not defined by my grade."

Mastery Experience: Mental Practice

Participants were asked whether they had any experiences mentally practicing or visualizing the problem-solving process in this course. Out of ten participants, only four of them reported they had visualized the problem-solving process. One said she did it before getting started on the assignment when she read the scenario. One reported that "There were several assignments that I even dreamed about working through." Another student reported, "I have been thinking about the statistics used in the Covid-19 vaccine studies and what the data means." In contrast to those who reported the voluntary visualization process for problem-solving, one participant stated, "I tried but often it felt very abstract."

When asked about what strategies could help students mentally practice or visualize solving problems in learning statistics, one student frankly said that was "a natural go-to for me so I don't know how to help others with this one." Meanwhile, several participants offered more concrete ideas, such as using visualization tools such as tables and charts in learning to help understand. Another student suggested applying the statistical concepts to ongoing current events in the real world to build connections.

RQ2: Instructional Strategy Usage, Self-efficacy, and Anxiety

The reliability of the 7-item self-efficacy measure was first assessed using Cronbach's alpha. The

Table 2. The Descriptive Statistics of Self-efficacy on Seven Domains (N=10)

Tasks in the Online Introductory Statistical Course	Mean	Standard Deviation
I can propose a quasi-experimental design that is related to my work experience and write the research questions/hypotheses.	79.00	12.21
I can use descriptive statistics in SPSS to understand data.	86.00	16.85
I can conduct a correlational analysis in SPSS.	88.00	14.70
I can conduct a simple regressional analysis in SPSS.	88.00	17.20
I can conduct an independent samples t-test in SPSS.	92.00	11.66
I can conduct a dependent samples t-test in SPSS.	92.00	11.66
I can conduct a one-way ANOVA with Post Hoc in SPSS.	91.00	12.21

Table 3. The Descriptive Statistics of ALA Self-efficacy Questions (N=10)

ALA Questions	Mean	Standard Deviation
When I am feeling tired.	65.00	25.40
When I am feeling under pressure from work.	68.00	25.62
After recovering from an injury that interrupted my learning.	62.00	24.41
When I am experiencing personal problems.	59.00	25.87
When I am feeling depressed.	55.00	28.72
When visitors are present.	51.00	26.63
When there are other interesting things to do.	80.00	8.94
When I am not getting near my learning goals.	74.00	19.08
When I have other time commitments.	56.00	30.72

seven self-efficacy items that are aligned with the course domains were found to be highly reliable (α = .960), which is consistent with Huang and Mayer's (2019) study (α = .960). The participants' self-efficacy towards the doctoral-level introductory online statistics learning had a mean of 88 (*SD* = 14.70) on the 0–100 scale. In the item-level analysis of the 7-item self-efficacy measure (see Table 2), a repeated-measures ANOVA revealed a significant difference among seven items, $F(6, 54) = 4.319$, $p = .001$. partial $\eta^2 = .084$. Participants rated *t*-tests (including independent samples *t*-test and dependent samples *t*-test) equally the highest (*M* = 92, *SD* = 11.66) while proposing a quasi-experimental design/writing the research questions the lowest (*M* = 79, *SD* = 12.21).

The ALA self-efficacy measure (Ponton et al., 2005) asked participants how sure they were that under different circumstances they could get themselves to study statistics without being required to do so. Participants in this study had a mean of 63.33 (*SD* = 26.39; α = .935) on the 0–100 scale. In the item-level analysis of the nine ALA self-efficacy measures (see Table 3), a repeated-measures ANOVA also revealed a significant difference among nine self-efficacy questions, $F(9, 72) = 3.422$, $p = .002$. partial $\eta^2 = .114$. Having visitors at home while studying seemed to be the most challenging and distracting circumstance to students' learning (*M* = 51, *SD* = 26.63) while interesting things (e.g., playing games, going out for fun) were not (*M* = 80, *SD* = 8.94).

Additional statistical analyses were conducted to examine the relationship between students' instructional strategy use, self-efficacy, and learning anxiety in learning statistics online. Based on the qualitative results in the first phase, a majority of the students found it difficult to use mental practice in learning statistics while some found it natural and easy. Such a discrepancy warranted an independent samples *t*-test to examine the students' self-reported anxiety and self-efficacy between those using mental practices versus their counterparts who did not. Statistical significance was observed on self-reported anxiety, $t(7) = -2.313$, $p = .027$, $d = 1.37$. and self-efficacy defined by course tasks, $t(7) = 2.948$, $p = .016$, $d = 1.71$. On the ALA that measures adult learners' autonomous learning, the group using mental practices showed more willingness to study (*M* = 71.38, *SD* = 22.40) than those who do not practice mentally (*M* = 57.96, *SD* = 20.38). However, there was no statistical significance, $t(7) = 0.962$, $p = .186$.

DISCUSSION

The primary purpose of this study was to examine nontraditional students' perception of the instructional strategies in a doctoral-level introductory online statistic course in an Educational Leadership doctoral program at a public university in Texas. We wanted to find out which instructional strategies helped with students' online statistics learning. Based on Bandura's (1997) four sources of self-efficacy, we focused on the instructional strategies that are closely aligned to vicarious experience, social persuasion, affective states, and mastery experience. The results suggest that students prefer live video modeling compared to the

worked example on paper to achieve a vicarious learning experience. This is consistent with Huang and Mayer's (2019) finding where a pedagogical avatar agent verbalizing the problem-solving process like an expert enhanced students' self-efficacy in an online statistics course. While a pedagogical agent may not be readily available in all educational programs due to its high cost, a prerecorded video lecture where a real person (i.e., the instructor) verbalizes the problem-solving process seems more economically viable. Vicarious learning is derived from indirect sources including hearing and observation (Bandura et al., 1963; Mayes, 2015). In the online environment where direct, hands-on instructions are absent, utilizing video live modeling (e.g., Zoom recording) to ensure students listen, watch, and observe to learn is fundamental to online learning success. This is in the same line as the multimedia recorded tutorial dialogues Mayes (2015) suggested. From the course design perspective, the specific tool and method could vary depending on the setting and the target audience. The key point is to offer dynamic modeling of the problem-solving process where students can watch and experience the whole process, instead of reading words on paper. Some of the viable approaches include synchronous sessions with real-person, live modeling and building small-group dialogues to elicit self-explaining and deep questioning among students.

While ability feedback (x out of y points) is direct and effective in the early stage of skill development (Bandura, 1997; Schunk, 1984), the results of this study ubiquitously indicate students' preferences for effort feedback that encompasses understanding, grace, and psychological support. The encouraging, explicit feedback helped students cope with statistics anxiety and survive the course. Zimmerman and Johnson (2017) found students' attitude towards the statistics instructor was a significant predictor of course completion. With instructor support well-delivered through the effort attributional feedback, the students seem more likely to have less anxiety and have more positive attitudes towards statistics. According to Dweck (2008), ability feedback tends to relate to a fixed mindset whereas effort feedback promotes a growth mindset. When encouraged to make more efforts, students tend to view intelligence as malleable with effort, thus increasing their likelihood of facing the challenges and succeeding. This is true in Huang and Mayer's (2019) study where attribution feedback via the pedagogical agent was found promising to achieve the desired self-efficacy among students. In the current study, a majority of the students had a deep understanding of the explicit supporting messages the real person (i.e., instructor) shared with them thus and were able to recite and write them out verbatim.

The quantitative self-reported efficacy and anxiety data echo such findings. With the instructional strategies (i.e., video modeling, explicit message, effort attributional feedback) discussed above, students' confidence increased towards the latter section of the course. Meanwhile, students' domain-specific self-efficacy seems higher compared to their efficacy in autonomous learning. To nontraditional students, having a sense of personal efficacy when engaging in autonomous learning is critical, but challenging. Nontraditional students are more likely to have a good sense of efficacy against the distraction of interesting things in life as compared to having visitors. Ponton (2021) pointed out that the lower efficacy with visitors present could be due to either people having a low perception of their ability to successfully avoid the distraction of visitors, or they had a strong belief that they are not able to avoid the external distractor (e.g., visitors) that are out of their control. This is a typical situation for nontraditional students given the varied roles they play in the real world (e.g., employee, supervisor, parent, student, son, daughter, grandparent). They are consistently challenged in balancing all their responsibilities, which could lead to frustration with everything. Thus, this poses challenges to the online instructors and course designers in finding evidence-based tools and incorporating such tools and strategies to facilitate nontraditional students' learning.

While three sources of self-efficacy (i.e., vicarious experiences, social persuasion, affective states) are present in the introductory online statistics course, mastery experience seems more challenging to achieve. Despite quite a few participants finding mental practice helpful in learning statistics, most found the problem-solving process of statistics to be too abstract to mentally rehearse. Such a different view echoes the finding that students who were able to practice mentally had less anxiety and a greater level of domain-specific

efficacy than their counterparts. Schunk and DiBenedetto (2016) consider mastery experiences the most significant source of efficacy. Mental practices were found effective in facilitating students' statistics learning online when a pedagogical agent asked students to mentally re-hear before completing the task (Huang & Mayer, 2019). However, this appears to be a missing puzzle piece in the introductory statistics course in this study. Thus, it raises the challenge to the online course designer to find creative, economically viable ways to incorporate the mental practice component in the course design for students to use.

Limitations

While our findings share insights about the instructional strategies in enhancing students' self-efficacy in online statistics learning, there are several methodological limitations in this study. First, generalization of the findings is limited given a small sample size from a single doctoral program at one institution. The findings of this study may not be generalized to the entire adult, nontraditional graduate student population in all institutions. Furthermore, caution needs to be particularly taken on the statistical significance found in this study because of the small sample size. Further investigations with a larger sample that covers other disciplines in multiple programs and institutions are strongly recommended.

Implications for Further Research

The findings of this study inspire researchers to further examine the effectiveness of instructional strategies in more disciples and different courses at different educational levels. Considering that the participants in this study are from one doctoral-level statistics course in the educational leadership field, further studies should be conducted in various courses and diverse disciplines (e.g., social science, STEM, etc.) to see whether different courses/disciplines require different instructional strategies to enhance students' self-efficacy. Furthermore, this study is based on an asynchronous online environment, so it would be interesting to examine the instructional strategies in synchronous settings. A comparative examination of synchronous and asynchronous online instruction could offer more insights regarding the effectiveness of the instructional strategies on self-efficacy. Further study should also consider diverse cultural variances among students concerning the instructional strategy effectiveness in online teaching. The students' varied cultural backgrounds may bring diverse cultural dynamics and influences on how they perceive the effectiveness of the instructional strategies, thus affecting their self-efficacy in online learning.

PRACTICAL IMPLICATIONS

This study suggests that more live modeling, effort feedback, explicit messages, and mental practice are greatly needed to enhance nontraditional students' self-efficacy in statistics online learning. Martin and Oyarzun (2018) proposed different online learning modalities, including asynchronous online learning, synchronous online learning, Massive Open Online Courses (MOOCs), and blended/hybrid learning. Regardless of the online learning modality, online instructors and course designers need to be mindful of such needs to find creative strategies to incorporate such components into the online course design, particularly on mental practicing strategies to enhance students' mastery experience. Similar to math, statistics spark anxiety among students, thus leading to low self-efficacy and low performance. In an online environment where face-to-face support is scarce, instructors should carefully examine each course component in the design and the instructional strategies utilized in delivery to assess their roles in facilitating students' self-efficacy in online learning. For example, recording a video to showcase the problem-solving process, instead of providing step-by-step instructions on paper, helps with vicarious experience to enhance self-efficacy. Provide encouraging, explicit messages in the feedback to recognize students' effort. Encourage synchronous interaction and praise students' effort before setting expectations. Such instructional strategies can enhance social persuasion, affective states, and vicarious experience and bring the most powerful tools for online instructors. Meanwhile, this study calls for more timely support from university administrations to bring changes to online course design (i.e., use the pedagogical agent and animation avatars to streamline students' online learning experience). Also, training or workshops would be beneficial for online instructors and course designers to improve their evidence-based instructional strategies.

CONCLUSION

While the COVID-19 pandemic still impacts the education systems worldwide, one of the pressing challenges all educators continue to face is how to offer quality online education. To this end, it is important to explore and identify the most effective instructional strategies that could help enhance online learners' self-efficacy and improve their learning outcomes. The findings of this study will help online course instructors, course designers, and higher education administrators in better meeting the needs of online learners by incorporating effective instructional strategies in online courses. We hope the findings of this study will inspire more online instructors to create varied live modeling, offer creative effort feedback, provide more explicit messages, and incorporate more mental practicing activities into their online course design so that students' self-efficacy, as well as their learning outcomes, can be enhanced.

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APPENDIX A

Please reflect on your statistics learning experiences in the online statistics course you took and answer the open-ended questions below. Please include as much detail as possible.

1. In this online statistics course, which has helped you learn?
   A) the "how to . . . step-by-step" PDF. format
   VIDEO modeling examples with oral explanations, or
   B) the "how to . . . step-by-step" **WORD** document/book that provides worked examples? Please pick one and elaborate WHY with details.

2. People learn when they observe others or model example/performance. Do you think there are other good models/examples that could be used in this course?

3. In this online statistics course, which type of instructor's feedback have you received? A) you were told you received x out of y points, or B) you were praised for the effort you made and you were encouraged to make more effort on the next assignment. Please pick one and elaborate WHY with details.

4. Instructors' feedback plays an important role in students' learning. What other type of feedback could be included in this course if there were any?

5. In this online statistics course, have you been motivated by the instructor that your statistics ability is changeable?
   a. If yes, what have you been told? If possible, include as much detail verbatim as possible.
   b. Do you think this message is implicit or explicit?
   c. If the message is implicit, please provide an example that you would like to receive in the future.
   d. Indicate whether you would like an implicit message or an explicit message.

6. Students' anxiety in learning highly impacts learning outcomes. Can you think of any strategies that can help you cope with learning anxiety in this course?

7. In this online statistics course, have you had any experiences mentally practicing or visualizing the problem-solving process in this course? If yes, how? Please provide as much detail as you can.

8. Can you think of any strategies that could help you mentally practice or visualize solving problems in learning statistics? Please provide if you can.

APPENDIX B

In each of the following tasks, please rate how confident you are in performing the task from 0 (*no confidence at all*) to 100 (*extremely confident*).

0	10	20	30	40	50	60	70	80	90	100
No confidence at all				Moderately confident						Extremely confident

1. I can propose a quasi-experimental design that is related to my work experience and write the research questions/hypotheses.
2. I can use descriptive statistics in SPSS to understand data.
3. I can conduct a correlational analysis in SPSS.
4. I can conduct a simple regressional analysis in SPSS.
5. I can conduct an independent samples *t*-test in SPSS.
6. I can conduct a dependent samples *t*-test in SPSS.
7. I can conduct a one-way ANOVA with Post Hoc in SPSS.

APPENDIX C

APPRAISAL OF LEARNER AUTONOMY (ALA)

In responding to the items below, insert any score (0–100) using the following scale:

0	10	20	30	40	50	60	70	80	90	100
Cannot do at all				Moderately certain can do						Certain can do

In each of the following situations, please rate how sure you are that you can get yourself to study statistics when nobody else requires you to do so. Note that statistics is what you believe will help you to learn something that you want to learn. (0–100)

1. When I am feeling tired
2. When I am feeling under pressure from work
3. After recovering from an injury that interrupted my learning
4. When I am experiencing personal problems
5. When I am feeling depressed
6. When visitors are present
7. When there are other interesting things to do
8. When I am not getting near my learning goals
9. When I have other time commitments