ACUE

Impacts of Faculty Development on Faculty's Mindsets and Self-Efficacy

ASSOCIATION OF COLLEGE AND UNIVERSITY EDUCATORS

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EXECUTIVE SUMMARY

Faculty are subject matter experts, yet many lack comprehensive pedagogical training. To bridge this gap and enhance instructional quality, faculty development programs have emerged, aiming to provide faculty with the necessary information and skills to become more effective educators. While some faculty development programs merely convey information, others also incorporate opportunities for practice and reflection to support growth in self-efficacy and mindsets. Research has established strong connections between teacher self-efficacy and behaviors that foster student achievement (Allinder, 1994; Woolfolk & Hoy, 1990), and has shown that instructors with a growth mindset positively influence their students' educational outcomes (Canning et al., 2019; Muenks et al., 2020). Moreover, it is of practical interest for higher education to better understand whether faculty development as a student success intervention relies on preexisting positive faculty mindsets versus having the concurrent effect of developing mindsets and effective teaching practices.

This research paper's primary aim is to explore the efficacy of comprehensive faculty development that emphasizes growth in faculty self-efficacy and mindsets. A secondary aim is to explore the relationship between this type of faculty development and the self-efficacy and growth mindsets of students. We focus our analyses on faculty who teach (and the students enrolled in) "gateway courses."

Faculty members teaching gateway courses at 10 colleges and universities were recruited to participate in comprehensive faculty development courses, offered by the Association of College and University Educators (ACUE), in Effective Teaching Practices (ETP) or Effective Online Teaching Practices (EOTP). Ultimately, a total of 571 faculty members engaged in the ACUE courses. Both ACUE faculty participants and a comparison group of 1,062 faculty members who taught gateway courses at the same institutions but did not enroll in ACUE courses participated in four waves of surveys, covering the time period from the beginning of the ACUE course to one semester after the course ended.

The surveys aimed to assess faculty mindsets related to their role as educators, their self-efficacy in employing effective teaching practices, their utilization of courseware and digital tools in gateway courses, and their awareness of and attitudes toward their institution's initiatives regarding gateway courses. These surveys captured data points from before the start to after the completion of the ACUE course, enabling us to observe changes over time. Changes in faculty self-efficacy and mindsets, our primary research interest, were measured using linear multilevel models.

Student surveys were also administered to students of ACUE faculty members, aimed at assessing students' perceptions of their instructors' instructional practices, growth mindset, academic self-efficacy, belonging, perceptions of campus climate, and attitudes toward their institution's student success efforts.

The findings demonstrate the effectiveness of comprehensive faculty development in promoting positive shifts in faculty self-efficacy and mindsets. Results revealed consistent improvements across all dimensions of self-efficacy, with a particularly strong impact on faculty's self-efficacy in implementing evidence-based teaching practices. The positive effect observed at follow-up indicates the potential long-term benefits of faculty development in promoting self-efficacy among faculty members. Analyses also found a sustained and stable effect on average mindset ratings over time. The positive increases in all mindset subscales, particularly in the follow-up period, indicate a holistic transformation in faculty perceptions and attitudes towards teaching and learning. Analysis of the student survey demonstrated that students perceived a significant increase in their growth mindset and academic self-efficacy from the start of the semester to the end of the semester, suggesting that ACUE faculty positively influenced their students' mindsets.

Taken together, the faculty and student survey results not only support the hypothesis that comprehensive faculty development improves faculty's mindsets and self-efficacy, but also shows that the mindset shifts among faculty might have an impact on students as well. Given the research linking students' growth mindset to their performance (e.g., Robins & Pals, 2022),

we would expect these changes in faculty and student mindsets to be followed by improvements in students' course performance.

While the current study focused specifically on ACUE's Effective Teaching Practice Framework Certification, the findings may apply to faculty development more broadly, so long as faculty development programs are comprehensive, include a focus on growth mindset, and use a learning design that supports changes in self-efficacy and mindset, such as through expectations to implement recommended practices and reflect on the student impact and areas for refinement. As such, these results contribute to the existing literature on faculty development, underscoring the importance of targeted faculty development initiatives in promoting effective teaching practices and fostering a growth-oriented mindset among faculty members.

INTRODUCTION

College and university faculty stand as authorities within their fields of study, wielding a wealth of expertise and knowledge. Their contributions to research and academia allow them to shape the academic landscape through their deep understanding and use of specialized research methods. However, a disconcerting reality persists: despite their subject expertise, many faculty members lack adequate pedagogical training. As their role includes the essential task of educating college students, the absence of comprehensive formal training in effective teaching practices may hinder their ability to fully realize their potential as educators. This glaring disparity between disciplinary mastery and pedagogical preparation also raises pressing concerns about the overall quality of education being imparted to students, as research connects specific effective teaching practices to students' academic outcomes (e.g., Freeman et al., 2011). To bridge this gap and enhance instructional quality, faculty development programs have emerged, aiming to provide faculty with the necessary information and skills to become more effective educators.

Comprehensive faculty development programs go beyond merely conveying information. They recognize that to make improvements in learning opportunities fully effective, it is essential to address psychological obstacles to learning. The reverse is also true: addressing psychological obstacles to learning will only be effective when accompanied by actual learning opportunities (Walton & Wilson, 2018; see also Bandura & Schunk, 1981; Menec et al., 1994). Thus, we define comprehensive faculty development as positively shifting instructors' beliefs—particularly regarding their teaching abilities, their role as instructors, and their students—through practice and reflection. Crucial components of these beliefs are self-efficacy and mindset. Self-efficacy refers to one's belief in their ability to organize and carry out actions to achieve desired outcomes (Bandura, 1977, 1997). It reflects one's confidence in their ability to regulate their own motivation, behavior, and social environment. Mindset, on the other hand, is a framework for beliefs about the nature of intelligence and other characteristics (Dweck, 1999, 2006). It describes core assumptions about the malleability of individuals' personal qualities and the world around them (Dweck & Leggett, 1988). Mindset thus shapes how one interprets events and influences their behavior. Research has established strong connections between teacher self-efficacy and behaviors that foster student achievement (Allinder, 1994; Woolfolk & Hoy, 1990). It has also shown that instructors with a growth mindset positively influence their students' educational outcomes (Canning et al., 2019; Muenks et al., 2020). By engaging in comprehensive faculty development programs, faculty members should undergo a transformation in their orientation towards their instructional role and their students, which we expect will positively influence the implementation of effective teaching practices.

This research paper aims to achieve two main objectives: first, to examine the impact of comprehensive faculty development on participants during and after their engagement, and second, to explore the relationship between comprehensive faculty development and the self-efficacy and growth mindsets of students.

This research paper aims to achieve two main objectives: first, to examine the impact of comprehensive faculty development on participants during and after their engagement, and second, to explore the relationship between comprehensive faculty development and the self-efficacy and growth mindsets of students. The paper also includes additional objectives of exploring faculty and student perceptions of instructional practices and digital tools in gateway courses, as well as student success initiatives and campus climate and belonging. To achieve these objectives, our analysis focuses on faculty members who teach "gateway courses, " which are foundational courses with high enrollments and high rates of students receiving D's, failing, or withdrawing (DFW rates; Koch, 2017). Gateway courses have an important impact on student retention rates and completion rates, especially among students facing systemic barriers (Koch, 2017), with students who successfully complete these courses within their major during their first semester being more likely to persist and enroll in subsequent semesters (Flanders, 2017). Thus, gateway courses are one of the most important challenges in improving student success, but despite their crucial role they have often been overlooked in previous student success efforts (Koch, 2017). By focusing on faculty development as a student success initiative, we aim to understand strategies that support the success of faculty teaching gateway courses. This approach can have a significant impact on a large number of students per faculty member, particularly those students who are at risk of leaving an institution and not achieving their educational goals (Flanders, 2017; Koch & Drake, 2018).

In all, we investigate six research questions to better understand the effectiveness of comprehensive faculty development programs and their impact on faculty and students in gateway courses. Our research questions encompass two distinct domains: faculty-related inquiries (Research Questions 1–3) and student-related inquiries (Research Questions 4–6). Nevertheless, our primary focus is faculty self-efficacy and mindset (Research Question 1), with a secondary focus on student academic self-efficacy and growth mindset (Research Question 4). The research questions are as follows:

RQ1: How effective is comprehensive faculty development focused on effective teaching practices at improving faculty self-efficacy and mindset?

RQ2: How extensively do instructors of gateway courses utilize digital tools? To what extent does their usage of digital tools change after participating in faculty development focused on effective teaching practices?

RQ3: To what extent are faculty members aware of their institution's student success initiatives related to gateway courses? How positively do they perceive these initiatives? To what extent do their awareness and attitudes change after participating in faculty development focused on effective teaching practices?

RQ4: To what extent are students' self-efficacy and growth mindset influenced when faculty members engage in faculty development focused on effective teaching practices?

RQ5: Do student reports show that faculty implemented the instructional practices they learned through faculty development? To what extent do students in gateway courses perceive that their instructors' utilization of digital tools and other instructional resources facilitated their learning?

RQ6: How positively do students in gateway courses perceive the campus climate, belonging, and efforts for student success?

We employed the following approach to address these research questions. First, faculty members teaching gateway courses at the participating colleges and universities were recruited to participate in faculty development courses, offered by the Association of College and University Educators (ACUE), in Effective Teaching Practices (ETP) or Effective Online Teaching Practices (EOTP). These ACUE courses are grounded in the Effective Teaching Practice Framework (ACUE, 2016), which encompasses 25 evidence-based teaching competencies categorized into five key units of study.

To ensure diverse representation, colleges were selected with consideration of specific criteria. Ultimately, a total of 571 faculty members from 10 institutions engaged in the ACUE courses. During the course duration, both ACUE faculty members and a comparison group of 1,062 faculty members who taught gateway courses at the same institutions but did not enroll in ACUE courses participated in four waves of surveys. The surveys aimed to assess faculty mindsets related to their role as educators, their self-efficacy in employing effective teaching practices, their utilization of courseware and digital tools in gateway courses, and their awareness of and attitudes toward their institution's initiatives regarding gateway courses. These surveys were administered between January 2022 and May 2023, capturing data points from before the start to after the completion of the ACUE course, thus enabling us to observe changes over time. Changes in faculty self-efficacy and mindsets, our primary research interest, were measured using linear multilevel models.

Student surveys were also administered, aimed at assessing students' perceptions of their instructors' instructional practices, growth mindset, academic self-efficacy, belonging, perceptions of campus climate, and attitudes toward their institution's student success efforts. Instructors who participated in the ACUE courses were requested to distribute these surveys to their students at the conclusion of the spring 2022 and fall 2022 semesters.

By integrating survey data from faculty and students, our study provides a comprehensive analysis of how these key factors evolve and interact within the context of gateway courses. Through a comprehensive understanding of how confidence and mindset impact teaching practices and student outcomes, we can develop more effective strategies to support faculty growth and foster positive learning environments.

PREVIOUS LITERATURE AND INTERVENTION

Self-Efficacy

Psychologist Albert Bandura (1977) first introduced the construct of self-efficacy, which is defined as an individual's belief in their own capacity to organize and execute the courses of action required to produce desirable outcomes (see Bandura, 1997). Self-efficacy is important because people need to believe they can achieve a goal to pursue it (Bandura, 1999). High self-efficacy leads to motivation, interest, and embracing challenges, while low self-efficacy can result in giving up easily (Bandura, 1986). For these reasons, self-efficacy beliefs are especially important in education.

In the context of education, self-efficacy has been widely recognized as a significant factor influencing both students and educators. For students, self-efficacy beliefs play a critical role in their motivation, academic performance, and achievement (Bandura & Locke, 2003; Gore, 2006; Multon et al., 1991). When students possess high self-efficacy, they are more likely to set challenging goals, exert effort, persist in the face of obstacles, and exhibit a proactive approach to learning (Pajares, 2002). They believe in their abilities to overcome difficulties, and this belief fuels their motivation to actively engage in academic tasks. On the other hand, students with low self-efficacy tend to doubt their capabilities and may exhibit learned helplessness, leading to decreased effort, disengagement, and lower academic achievement (Zimmerman et al., 1992).

Teacher self-efficacy is equally important in education. Teacher efficacy refers to educators' (e.g., pre-service teachers, K–12 teachers, and college instructors) belief in their ability to plan and execute the courses of action needed to successfully complete a specific teaching task in a particular context and to positively impact student learning outcomes (Berman et al., 1977; Tschannen-Moran et al., 1998; see also Guskey & Passaro, 1994). Research has consistently demonstrated the influence of teacher efficacy on various aspects of teaching and student outcomes. For example, educators with high self-efficacy are more likely to demonstrate

certain behaviors, such as setting high expectations for their students, persisting in the face of challenges, utilizing effective instructional strategies, and trying innovative approaches to improve student learning (Allinder, 1994; Ashton & Webb, 1986; Berman et al., 1977; Coladarci, 1992; Gibson & Dembo, 1984; Hoy, 2004; Ross et al., 1996; Tschannen-Moran & Hoy, 2001; Woolfolk & Hoy, 1990). Consequently, students taught by educators with high self-efficacy exhibit higher academic achievement, better problem-solving skills, increased self-regulation, and higher sense of efficacy (Anderson et al., 1988; Ashton & Webb, 1986; Tschannen-Moran & Hoy, 2001). Conversely, low teaching efficacy can hinder instructors from embracing effective teaching practices, limiting student engagement, learning, and achievement. Research has also positively connected teachers' collective efficacy at the organizational level to a range of student outcomes (Goddard et al., 2004; Moolenaar et al., 2012).

By enhancing teacher efficacy, faculty development initiatives should be better positioned to shape effective learning environments, boost student engagement, and promote academic achievement.

Given the impact of self-efficacy on students and educators, these findings hold broad implications for educators and administrators. Developing students' self-efficacy requires creating supportive learning environments through adaptations in syllabi and the design of classroom activities (Komarraju & Nadler, 2013). However, for educators to effectively adapt their teaching practices and motivate students, it is vital for them to believe they have control over the curriculum, materials, and learning environment (Tschannen-Moran et al., 1998). In other words, educators must possess the confidence that they can effect change, even for students who may be perceived as difficult or unmotivated.

Recognizing the significance of teacher efficacy, faculty development programs that enhance the self-efficacy of college instructors assume importance in higher education. These initiatives are particularly crucial for faculty with limited pedagogical training, providing opportunities for educators to enhance their knowledge, skills, and confidence in improving

instructional practices. By enhancing teacher efficacy, faculty development initiatives should be better positioned to shape effective learning environments, boost student engagement, and promote academic achievement.

Mindset

Mindset theory, popularized by psychologist Carol Dweck, refers to an individual's beliefs and attitudes about the malleability of personal qualities, such as intelligence (Dweck, 1999, 2006; Dweck & Leggett, 1988). The two primary mindsets discussed in the literature are the growth mindset and the fixed mindset.

Individuals with a growth mindset believe they can grow a particular attribute or trait through effort, effective strategies, and learning from mistakes (Dweck, 2006). Thus, this mindset fosters a belief in the potential for growth, resilience, and a willingness to embrace challenges as opportunities for learning and improvement. Conversely, individuals with a fixed mindset believe that intelligence or other abilities and attributes are fixed traits that cannot be significantly altered. They tend to approach challenges with less motivation and fear failure, perceiving it as a sign of wasted effort rather than a path to improvement (Burnette et al., 2013; Dweck, 2006, 2012).

Studies examining student mindsets regarding intelligence have revealed significant connections between mindset beliefs and academic outcomes. Students with a growth mindset tend to display greater motivation, effort, and engagement in learning (Blackwell et al., 2007; Dar-Nimrod & Heine, 2007; Dweck, 2006). They are also more likely to persist through challenges, exhibit higher academic achievement, and demonstrate increased resilience in the face of setbacks and stereotypes (Dweck, 2006; Good et al., 2003; Yeager & Dweck, 2012). In contrast, students with a fixed mindset may experience decreased motivation, lower academic performance, and reduced self-esteem (Blackwell et al., 2007; Dweck, 2006).

More recently, research has also turned to exploring teacher mindset and its implications for educational practice. Teachers' beliefs and mindsets have been found to significantly influence their instructional practices, classroom climate, and student outcomes (Canning et al., 2019; Muenks et al., 2020). Teachers with a growth mindset tend to embrace challenges, view student difficulties as opportunities for growth, and adopt instructional strategies that promote a growth-oriented learning environment (Good et al., 2007; Huang, 2023; Rattan et al., 2012). In contrast, teachers with a fixed mindset may exhibit lower expectations for student growth, have less confidence in their ability to support struggling students, and be less likely to incorporate effective instructional strategies (Burnette et al., 2013; Rattan et al., 2012).

By addressing and fostering positive mindsets among faculty members, professional development programs should empower educators to create learning environments that promote resilience, effort, and a belief in the potential for growth among students.

These findings highlight the importance of incorporating mindset-related strategies into faculty development initiatives in higher education. By addressing and fostering positive mindsets among faculty members, professional development programs should empower educators to create learning environments that promote resilience, effort, and a belief in the potential for growth among students. This is of particular importance for faculty teaching gateway courses, in which students are more at-risk for failure or non-completion of the course. Considering that research establishes a connection between success in gateway courses and student retention (Flanders, 2017; Koch & Drake, 2018), focusing comprehensive faculty development on faculty teaching these courses should yield greater benefits for students who take these courses early in their college careers. Furthermore, faculty development programs can provide opportunities for self-reflection and self-assessment to help educators recognize their own mindsets and beliefs about intelligence and abilities. By cultivating awareness of fixed mindset tendencies, faculty members can challenge and transform their own thinking, adopting a growth-oriented approach to teaching and learning.

Faculty Development Intervention: Effective Teaching Practice Framework Certification

The Association of College and University Educators (ACUE) developed the Effective Teaching Practice Framework—a consensus statement of the teaching skills and knowledge that every college educator should possess to teach effectively, regardless of discipline (ACUE, 2016). The framework consists of 25 evidence-based teaching competencies[1] organized into five major units of study and has been independently validated and endorsed by the American Council on Education (ACE, 2017). ACUE offers comprehensive courses and a four-course pathway that both lead to the Effective Teaching Practice Framework Certification. ACUE's faculty development courses are offered asynchronously online in a cohort-based model, with approximately 25–30 faculty per cohort. Faculty typically engage in the comprehensive courses over an entire academic year. ACUE's courses are designed to improve instructional practices and consequently impact student outcomes, through six levels of sequential outcomes (MacCormack et al., 2018): (1) faculty engagement, (2) faculty learning, (3) faculty implementation, (4) student engagement, (5) course-level student outcomes, and (6) institutional outcomes.

ACUE's learning design is aligned with research in cognition, andragogy, and online best practices. Each module in ACUE's courses includes the same components organized into five sections:

1) Engage: The introduction or opening questionnaire and learning objectives are designed to engage faculty, set clear learning goals, and activate prior knowledge.

2) Listen, Watch, and Learn: Course demonstration videos show faculty effectively using the module practices in authentic learning environments, while "Expert Insights" videos/podcasts explain what the practices are and the rationale behind them.

[1] A detailed description of all 25 competencies and their learning objectives can be found here.

Implementation resources provide additional details on how to implement the practices, with all these components building foundational knowledge.

3) Deepen Thinking: Faculty deepen their understanding through application by reading about common challenges and misconceptions, observing developing practice, either through a video or document, where some module practices are implemented effectively while others need some adjustment, and then participating in discussions with the peers in their cohort about what they observed in response to prompts.

4) Practice and Reflect: Faculty choose at least one practice to implement and write a reflection detailing why they chose the practice(s), how they implemented the practice(s), what impact they observed on their students, if any, and how they might refine their practice in the future. They then respond to a short survey to capture their learning and implementation.

5) Closing Strong: Faculty solidify their learning by writing a "note to self," which they can easily access at the end of their course, and can take additional steps in their learning by accessing the references that informed the development of the module.

This learning design promotes improved self-efficacy and mindset changes in several ways.

The course demonstration videos provide faculty with vicarious experiences of social models by showing other faculty successfully implementing the module practices. These vicarious experiences should increase faculty's self-efficacy to implement the module practices particularly since these videos use other faculty rather than experts, and thus should be perceived as more similar and relatable to course-takers, therefore increasing the impacts on self-efficacy (Bandura, 1994). Implementing the module practices and reflecting on how it went provides faculty with opportunities for mastery experiences, which, if they are

successful, are the largest influence on self-efficacy (Bandura, 1994). Even when faculty's initial implementation of a practice is perceived as not successful, the next steps section of the reflection assignment prompts them to consider what they could change about their implementation to be more successful in the future. In addition, the expectation that faculty implement a practice in every module encourages faculty to try new practices, even if they do not yet believe that changing their teaching will impact their students' engagement or performance. Then, the requirement to reflect specifically on how students responded prompts faculty to reconsider their beliefs about the impact of their teaching on students and students' ability to improve, which should result in improved mindsets. Furthermore, the repetition of this process through every module creates a recursive self-enhancing cycle (Walton & Wilson, 2018) that can be initiated by the change in behavior (i.e., implementation of the recommended practices; see Figure 1).

The current study will build upon the previous research, focusing on mindsets and self-efficacy among faculty who teach gateway courses and beginning to address student mindsets and self-efficacy to better understand how self-efficacy and mindsets contribute to the relationship between comprehensive faculty development and improved student outcomes.

Previous research has shown significant improvements in faculty's self-efficacy and beliefs after earning the Effective Teaching Practice Framework Certification (Lawner et al., 2020). However, this study used a retrospective pre/post design to survey faculty, rather than asking faculty to self-report their self-efficacy and beliefs at baseline and after their ACUE course, and it did not include a sample of faculty who did not participate in ACUE courses. Other research by ACUE, in collaboration with The University of Southern Mississippi, has examined the impacts of the Effective Teaching Practice Framework Certification among faculty teaching gateway courses, with improvements in grades, passing, and DFW rates in the gateway courses, particularly among first-year students (Pippins et al., 2021a), and lower DFW rates in students' subsequent course in the

same field (Pippins et al., 2021b). However, these studies focused on students' academic outcomes without exploring changes in faculty's self-efficacy and mindsets that may have preceded the improvements in students' course outcomes. The current study will build upon the previous research, focusing on mindsets and self-efficacy among faculty who teach gateway courses and beginning to address student mindsets and self-efficacy to better understand how self-efficacy and mindsets contribute to the relationship between comprehensive faculty development and improved student outcomes.

METHODOLOGY

Participants

Faculty

The research sample consisted of 1,633 unique faculty[2] affiliated with the institutions participating in the ACUE Faculty Mindset Research project. The institutions included are University of Houston; Borough of Manhattan Community College; California State University, Northridge; Cincinnati State Technical and Community College; Georgia Southern University; University of Hawaiʻi at Mānoa; Ivy Tech Community College; Lorain County Community College; North Carolina A&T State University; and Cuyahoga Community College. Out of the total sample, 571 faculty were ACUE participants, while 1,062 faculty served as the comparison group.

The research sample consisted of 1,633 unique faculty affiliated with the 10 institutions participating in the research project.

At baseline, 571 ACUE participants and 531 participants from the comparison group responded to the survey. Many participants,

[2] Throughout this study, the term "faculty" is used to refer to all types of instructors irrespective of their academic rank.

particularly from the comparison group, did not respond to all the surveys administered, as shown in Table 1.

We compared the reported demographics of the ACUE faculty and the comparison faculty in the analytic sample (see Table 2). There was no significant difference between the ACUE faculty and the comparison faculty in terms of rank distribution, $\chi 2(2) = 2.2769$, $p = .320$ (see Figure 2), or teaching format distribution, $\chi 2(3) = 4.8814$, $p = .181$ (see Figure 3).

There was a significant difference between the ACUE faculty and comparison faculty in terms of gender distribution, $\chi 2(3) = 14.2615$, $p = .003$. The ACUE group included a larger proportion of women and a smaller proportion of faculty that preferred not to report their gender compared to the comparison group (see Figure 4).

There was also a significant difference between the ACUE group and the comparison group in terms of race/ethnicity distribution, $\chi 2(5) = 34.0028$, $p < .001$. Among the ACUE faculty, there was a larger proportion of Black, Asian, and Hispanic faculty, while the comparison group had a larger proportion of White faculty (see Figure 5).

There was a significant difference in years of experience between the ACUE group and comparison group, $\chi 2(5) = 49.1037$, $p < .001$. The ACUE group had a smaller proportion of individuals with 20 or more years of experience and a larger proportion of individuals with 0–4 years, 10–14 years, and 5–9 years of experience relative to the comparison group (see Figure 6).

Finally, there was a significant difference in the proportion of institution type (2-year institution vs. 4-year institution) between the ACUE group and comparison group, $\chi 2(1) = 24.6574$, $p < .001$. The analysis shows that proportion of faculty affiliated with 4-year institutions was larger in the ACUE group compared to the comparison group (see Figure 7).

Students

The research sample consisted of 2,977 students enrolled in gateway courses taught by ACUE faculty participating in this research project in association with the 10 institutions previously mentioned. Valid survey responses were received from 1,017 students at the end of the spring

2022 semester and from 1,960 students at the end of the fall 2022 semester. Since students could have been enrolled in multiple gateway courses taught by participating faculty during the study period, it is possible that some students completed the survey for multiple courses or faculty; the anonymous nature of the survey does not allow us to determine if this occurred.

The average age of the spring 2022 sample was 23.99 years old (SD = 8.35), while the average age of the fall 2022 sample was 20.63 years old (SD = 5.40), $t(2675) = -12.554$, $p < .001$. There was no significant difference between the spring and fall samples in terms of gender distribution, $\chi 2(3) = 2.0530$, $p = .561$ (see Figure 8).

The race/ethnicity question was designed to allow students the opportunity to self-identify with multiple race/ethnicity groups, resulting in categories that are not mutually exclusive. Students who preferred not to not disclose their race/ethnicity or did not respond to this question were categorized as "unknown."

There was no significant difference in the proportion of American Indian/Alaskan Native students between the spring 2022 and the fall 2022 groups, $\chi 2(1) = 0.8330$, $p = .361$. There was a significantly larger proportion of Asian students in the spring 2022 group than in the fall 2022 group, $\chi 2(1) = 24.1807$, $p < .001$. There was a significantly larger proportion of Black/African American student in the fall 2022 group than in the spring 2022 group, $\chi 2(1) = 28.1227$, $p < .001$. In the case of Hispanic or Latino/Latina/Latinx students' proportion, there was no significant difference between the two groups, $\chi 2(1) = 1.4840$, $p = .223$. There was a marginally significant difference in the proportion of students of Middle Eastern/North African origin, $\chi 2(1) = 3.0667$, $p = .080$, with the spring 2022 sample presenting a slightly larger presence of students from this background. Likewise, the spring 2022 group had a significantly larger proportion of Native Hawaiian/Other Pacific Islander students than the fall 2022 group, $\chi 2(1) = 13.5622$, $p < .001$. There was no significant difference in the proportion of White students between the two groups, $\chi 2(1) = 0.0181$, $p = .893$. Likewise, there was no significant difference between the two groups based on students who identified as "Other race/ethnicity", $\chi 2(1) = 2.1015$, $p = .147$.

Finally, students who preferred to not disclose their race/ethnicity or did not respond to this question were categorized as "unknown." No significant difference between the two groups was observed for this category, $\chi 2(1) = 2.2316$, $p = .135$. See Figure 9 for the proportions of the sample reporting each race/ethnicity.

There was a significant difference in the proportions for class standing between the respondents from the spring 2022 and fall 2022 semesters, $\chi 2(6) = 24.3207$, $p < .001$. There was a smaller proportion of sophomore, graduate students, students who did not identify with any of the options, and students classified as "unknown" (students who did not respond to this question) and larger proportions of first-year, junior, and senior students in the fall 2022 group compared to the spring 2022 group (see Figure 10).

There was a significant difference between the fall 2022 and spring 2022 respondents in terms of student status distribution, $\chi 2(2) = 72.9933$, $p < .001$, with the fall 2022 sample presenting a larger proportion of full-time and a smaller proportion of part-time students and students of "unknown" status (students who did not respond to this question; see Figure 11).

There was a significant difference between the spring 2022 and fall 2022 samples in terms of course format distribution, $\chi 2(3) = 504.4959$, $p < .001$, with the fall 2022 sample having a larger proportion of students in face-to-face courses and a smaller proportion of students in online courses than the spring 2022 sample (see Figure 12).

Finally, there was a significant difference in the proportion of institution type (2-year institution vs. 4-year institution) between the spring 2022 and fall 2022 samples, $\chi 2(1) = 478.2732$, $p < .001$. The analysis shows that proportion of students enrolled in 4-year institutions was larger in the fall 2022 group than in the spring 2022 group (see Figure 13).

Procedures

Sampling Methodology

Colleges and universities were recruited for this study based on specific criteria to ensure representative samples, with a goal of conducting the study at eight institutions. The selection process considered factors such as geographic diversity, institution type, size, and whether schools were minority-serving institutions. The selected partners were deemed suitable for investigating the effectiveness of comprehensive faculty development. One of the partners, the Ohio Association of Community Colleges (OACC), selected three of its member institutions-- Cincinnati State Technical and Community College, Lorain County Community College, and Cuyahoga Community College—to participate, resulting in a sample of 10 US colleges and universities.

The selection process considered factors such as geographic diversity, institution type, size, and whether schools were minority-serving institutions.

Group Assignment

Each participating institution identified their gateway courses using the Bill and Melinda Gates Foundation's list of gateway courses as a starting point (see Table 3). They were able to identify courses as gateways even if they did not match a course on the foundation's list and could also include courses that they had not previously considered to be gateways if they clearly matched a course on the foundation's list. Developmental education and noncredit courses were excluded. Faculty teaching gateway courses at each institution were recruited to earn the Effective Teaching Practice Framework Certification through either ACUE's Effective Teaching Practices (ETP) or Effective Online Teaching Practices (EOTP) course, depending on the institution's preference. Three simultaneous cohorts of the ACUE courses were conducted at each institution—with the exception of the OACC schools, which each ran a single cohort—with 27–37 faculty initially

enrolled in each cohort. The courses ran from the beginning of spring 2022 to the end of fall 2022. Once the participants for the ACUE course (referred to as "ACUE faculty") were enrolled, all other faculty members teaching gateway courses at the participating institutions were recruited to serve as the comparison group. For both the ACUE group and the comparison group, there were no restrictions by employment status, rank, or years of experience; the only requirement for participation in the study was teaching at least one identified gateway course at one of the participating institutions.

Informed Consent

Prior to participation, all faculty members were provided with detailed information about the study's purpose, procedures, potential risks, and benefits. Informed consent was obtained from each faculty member, ensuring their voluntary participation and safeguarding their rights as research subjects. One faculty member enrolled in an ACUE cohort that was part of the study opted out of participating in the study; their survey data was excluded from all analyses. Ethical considerations, including participant confidentiality, were strictly adhered to throughout the study.

Data Collection Procedures

Surveys were administered at four different time points: baseline (early spring 2022 semester), midpoint (end of spring 2022 semester), endpoint (end of fall 2022 semester), and follow-up (end of spring 2023 semester). Adequate response time of approximately 4 weeks was provided for each survey administration. ACUE faculty completed surveys using their ACUE course learning management system (Canvas), while the comparison group faculty completed surveys using SurveyMonkey. Additionally, ACUE faculty completed brief surveys at the end of each module within the ACUE course.

The faculty surveys covered various dimensions, including demographics/background (baseline or first survey only), mindsets about teaching and students, self-efficacy in implementing evidence-based teaching practices, use of and attitudes regarding digital tools (baseline and endpoint surveys only), and awareness of and attitudes regarding student success initiatives (baseline and endpoint surveys only). The baseline, midpoint, and endpoint surveys for ACUE faculty also included additional questions that were standard in the ACUE course surveys, covering topics such as enrollment motivation (baseline survey), engagement (endpoint survey), and feedback on the course (midpoint and endpoint surveys).

The faculty surveys covered various dimensions, including mindsets about teaching and students and self-efficacy in implementing evidence-based teaching practices.

Data from student surveys were collected at the end of the spring 2022, fall 2022, and spring 2023 semesters. However, the response rate for spring 2023 was not sufficient for analysis, and thus those responses are not discussed in this paper. The surveys were electronically delivered through the course learning management system (Canvas) to ACUE faculty as SurveyMonkey links.

Faculty members then distributed the SurveyMonkey links to their students via email or the learning management system (LMS). The student surveys comprised a mix of multiple-choice and open-ended questions designed to assess students' growth mindset, self-efficacy, belonging, perceptions of their instructors' use of evidence-based teaching practices, and demographics/background. ACUE faculty were able to distribute the student survey to students in any of the courses they taught, since the survey was also used to provide faculty with formative feedback, but only responses from students in gateway courses were analyzed in this study.

Research Ethics

The study strictly adhered to ethical guidelines and obtained necessary approvals from relevant institutional review boards. Participant confidentiality was maintained throughout the research process, and all data were securely stored and accessed only by authorized personnel.

Measures

Faculty Survey

Mindsets Scale. We developed an 18-item Mindsets Scale to assess faculty's attitudes and beliefs related to their role as educators. We developed this scale based on some elements of the existing ACUE's End-Of-Course survey. ACUE's existing End-of-Course survey for the Effective Teaching Practice Framework Certification includes four items on beliefs about students and six items on teaching beliefs and behaviors. For this project, we added three additional items on beliefs about students and five additional items related to teaching beliefs and behaviors. The additional items for assessing beliefs about students all relate to growth mindset (adapted from Dweck, 1999), while the other additional items mostly expand on attitudes assessed through the original items to create a more reliable scale and come

from measures of teacher motivation (Hulleman et al., 2010). For example, one of the original items, "I am enthusiastic about teaching," is supplemented by the new item "Working with students is one of the most enjoyable aspects of my job."

While the beliefs about students and teaching beliefs and behaviors have generally been reported on separately to institutional partners, such as in summary reports, all the items used a 5-point Likert scale ranging from *strongly agree* to *strongly disagree*, with the same instructions; nothing about the survey distinguishes the two sets of items to faculty. Thus, for this project we examined all 18 items together as a measure of mindsets.

Factor analysis (see Results) shows that this scale includes five subscales: Perceived Teaching Effectiveness, Impact of Instruction of Students, Growth Mindset, Teaching Improvement Behaviors, and Teaching Enthusiasm. Items in the Growth Mindset subscale were reverse coded, ranging from 1 (*strongly agree*) to 5 (*strongly disagree*) since the statements' wording reflects a fixed mindset.

Self-Efficacy Scale. We developed a comprehensive 30-item scale to assess faculty levels of self-efficacy when using various effective teaching practices. All but one of these items came from ACUE's existing End-Of-Course survey, with each item aligning to a specific competency from ACUE's Effective Teaching Framework (2016). The item added for this project assesses self-efficacy using instructional resources. All items used a 5-point Likert scale ranging from *not at all* to *extremely*, with the same instructions asking faculty to rate their self-efficacy.

Due to an error that occurred when the modules for designing courses were updated, different versions of the seven items in the scale that correspond with those modules were inadvertently distributed to a large proportion of the ACUE participants on the endpoint survey. These seven items are included in the overall scale but were excluded from the factor analysis that was used to identify subscales (see Results). The 23-item version of the scale

comprises three subscales: Effective Teaching Practices, Adjusting Instruction, and Clarity in Instruction.

Use of Courseware/Digital Tools. The survey administered to the ACUE faculty and the comparison faculty additionally included a section assessing their engagement with courseware and digital tools in their gateway courses. This section consisted of five items aiming to assess the types and number of digital tools and courseware programs generally used by faculty in gateway courses, the course modalities in which these digital tools were used, the frequency of their use, and the extent to which faculty considered digital tools as valuable instructional resources.

Two of the items—frequency of use of digital tools and value of digital tools—used 5-point Likert scales. The two items asking participants to select the digital tools and courseware programs used presented their responses in a multi-select format, where participants could select all the options that applied. Finally, the item inquiring about the current use of digital tools in different course formats presented four options as potential responses, with the possibility to select only one option.

Awareness of and Attitudes Toward Institutional Initiatives. Finally, the faculty survey included a section aiming to evaluate faculty awareness of and attitudes toward their institution's gateway course initiatives. This section included two items with responses presented in a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). To provide comprehensive responses, participants were also given the option to select "I do not know" and "Not applicable" if relevant. The first item, specifically addressing the importance of the Gates Foundation and ACUE project, was only administered among ACUE faculty, while the item assessing the perceived effectiveness of their institution's initiatives focused on gateway courses was administered among ACUE and comparison faculty.

Additionally, this survey included items aimed to collect faculty demographic information, such as gender, race/ethnicity, rank, years of experience, among others. Faculty were provided with clear instructions on how to respond to each question and were encouraged to provide honest and thoughtful answers, emphasizing the importance of faculty's perspectives in understanding the use of digital tools and the effectiveness of institutional initiatives in gateway courses for this project.

Student Survey

The survey administered to students consisted of several scales and subscales designed to assess various aspects of the students' experiences related to and attitudes toward their academic experience at their institutions. Specifically, the measures aimed to assess students' perceptions of their instructors' instructional practices, growth mindset, academic self-efficacy, belonging, perceptions of campus climate, and attitudes toward their institution's student success efforts. The measurements included in this survey were as follows.

Instructional Practices Scale. The Instructional Practices Scale was designed to assess, from the student perspective, faculty members' use of the effective teaching competencies covered in ACUE's comprehensive course in Effective Teaching Practices or Effective Online Teaching Practices (Snow et al., 2022). The scale originally included 20 items (α = .972; e.g., "My instructor provided opportunities for all students to participate in discussions") with responses presented in a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). In addition, three more items were added to this scale specifically for this study to assess students' perception of whether their instructors' use of different instructional resources, technology tools, and digital courseware helped them learn.

Growth Mindset Scale. The Growth Mindset Scale aimed to measure students' beliefs about their intelligence and the potential for growth and change. This scale included three items from the most used scale to measure growth mindset designed by Dweck (1999). Participants were asked to indicate their level of agreement with each statement (e.g., "Your intelligence is something about you that you can't change very much.") on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Responses were reverse coded to appropriately indicate higher scores when students expressed lower agreement with statements opposed to growth mindset. The scale consisted of two sets of statements, each including the same items. In the first set of items, students were asked to respond according to their beliefs at the start of the semester (retrospective items) and, in the second set, they were asked to respond according to their beliefs at the time of taking the survey (current items).

The measures aimed to assess students' perceptions of their instructors' instructional practices, growth mindset, academic self-efficacy, belonging, perceptions of campus climate, and attitudes toward their institution's student success efforts.

Academic Self-Efficacy Scale. This scale was used to assess students' confidence in their abilities to perform various academic tasks, which were divided into two subscales, Communication and Self-Monitoring, based on a factor analysis conducted previously (Hecht, 2019). The Communication subscale included four items (e.g., "participate in class discussions") aimed to assess students' confidence to communicate in an academic setting. The Self-Monitoring subscale included four items (e.g., "keep up-to-date with your schoolwork") assessing students' confidence to self-monitor their academic performance. Participants were asked to rate their confidence level with each of the behaviors presented on a 5-point Likert scale, ranging from 1 (*not at all confident*) to 5 (*extremely confident*). This scale was adapted from The College System of Tennessee's Academic Mindset "Getting to Know Our Students Survey" (n.d.)

Attitudes Toward Student Success Efforts. This section of the survey included two items measuring students' attitudes toward their institution's commitment to their academic success and students' awareness of their institution's efforts to improve student academic success. The responses of the first item ("My institution is committed to my academic success.") were presented as a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*), with students asked to indicate their level of agreement. The second item ("*How aware are you of your school's efforts to improve student success?*") presented six different response options, aiming to distinguish to what extent students were aware of their institution's initiatives.

Campus Climate. The Campus Climate scale, which was adapted from the National College Climate Survey (Rankin et al., 2010), aimed to assess students' perceptions of their campus environment, specifically about their perceptions of faculty–student interactions, employee and administrator concern for student welfare, preconceived judgments, racial/ethnic tensions, and their institution's commitment to encouraging free and open discussion. Through this 7-item scale, participants were asked to rate their level of agreement with each statement on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Belonging Scale. This scale was included to assess students' sense of belonging in their course and perception of their bond, acceptance, and social interaction with others in their courses. It included one item adapted from a sense of community scale (Peterson et al., 2008) and previously used to measure belonging in college students (Findley-Van Nostrand &

Pollenz, 2017) and two items adapted from the Sense of Social and Academic Fit scale (Walton & Cohen, 2007), which has been widely used in research on belonging in higher education. Participants were asked to rate their agreement with each of the three statements presented on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*).

Additionally, this survey included several items regarding students' demographic information, such as age, gender, race/ethnicity, class standing, and course format, among others. Participants were assured that their responses would be kept confidential and that there were no right or wrong answers, emphasizing the importance of honest and thoughtful responses to guarantee the collection of accurate data.

DATA ANALYSIS PLAN

We first present the data analysis plan addressing the faculty-focused research questions and then move on to the data analysis plans for the student-focused research questions.

RQ1: How effective is comprehensive faculty development focused on effective teaching practices at improving faculty self-efficacy and mindset?

To address RQ1, we first performed an exploratory factor analysis (EFA) on the Mindsets and Self-Efficacy scales to identify the latent factor structure and assess the dimensionality, validity, and reliability of these assessment tools. Following this, we used confirmatory factor analyses (CFA) to validate the underlying factor structure identified by the EFA. We elaborate on the process and findings in the Results section.

Second, we employed a linear multilevel (or mixed effects) model (Harville, 1977; Laird & Ware, 1982; see also Singer & Willett, 2003) within a longitudinal analytic framework to examine how faculty self-efficacy and mindsets about their students' capabilities and potential evolved throughout the ACUE course.

The model captures how the mindsets and self-efficacy of individual faculty changed across four time points: spring 2022 (prior to participating in the ACUE course), summer 2022 (midway through the ACUE course), fall 2022 (at the end of the ACUE course), and spring 2023 (one semester after the end of the ACUE course).

Linear multilevel models are popular in education and behavioral research for modeling data with normally distributed outcome variables. The models can be fitted using maximum likelihood estimation (MLE), a technique that allows the model to utilize all available information from the observed data, instead of resorting to complete cases, to estimate the parameters (Skrondal & Rabe-Hesketh, 2008). MLE assumes that the missing data are missing at random (MAR) or missing completely at random (MCAR) (Little, 1995; Little & Rubin, 1989). If the missing data meet the MAR or MCAR assumptions, the parameter estimates obtained are valid and unbiased.

The estimation equation for our linear multilevel model is as follows:

$$Y_{ist} = \alpha_1(midpoint_t) + \alpha_2(endpoint_t) + \alpha_3(follow-up_t) + \sigma X_{ist} + \pi_s + \mu_i + \varepsilon_{ist}$$

Here, Y_{ist} is the self-reported rating of mindset or belief (on a 5-point Likert scale) for instructor *i* at institution *s* in term *t*. The parameters of interest, α_1, α_2, and α_3, represent the change in faculty mindsets and beliefs at the midpoint, endpoint, and follow-up, respectively, of their ACUE participation compared to the spring 2022 baseline; X_{ist} is a vector of instructor-level control variables; π_s and μ_i capture institution and instructor random effects, respectively; and ε_{it} represents the idiosyncratic error term. Instructor-level controls include indicators for race/ethnicity, gender, academic discipline (STEM vs. non-STEM), rank (tenure vs. non-tenure track), and level of experience (less than 5, 5–9, 10–14, 15–20, or 20+ years). We cluster our standard errors at the institution level to account for the non-independence of instructors' error terms within institutions.[3]

[3] We implement our analyses in Stata's *mixed* command, which, by default, uses the method of MLE (StataCorp, 2013).

The core assumption of the model is that faculty mindsets and beliefs would have remained relatively stable in the absence of the ACUE course and that no other concurrent events affected these outcomes.

This is a plausible assumption given the relatively short timeframe in which surveys were administered. In the Robustness section, we directly examined our assumption using survey data from our comparison group of faculty. However, considering the collection of comparison survey data, it is important to note that we did not primarily rely on a differences-in-differences (DID) method as our main analytic approach. The reason for this is that the comparison group consisted of faculty who varied more over time compared to the ACUE instructors. Unlike the ACUE instructors who were specifically identified, the surveys for the comparison group were intended to be sent to instructors of gateway courses each semester without targeting specific individuals.

The core assumption of the model is that faculty mindsets and beliefs would have remained relatively stable in the absence of the ACUE course and that no other concurrent events affected these outcomes.

Including the comparison group in our model could, therefore, introduce bias if the changing composition of the group violates the assumption of parallel trends. While techniques exist to account for missing data, we did not utilize them in this analysis as the reasons for the missing data were unknown. It is important to acknowledge the limitations of our approach and the potential impact of the compositional changes within the comparison group. We recognize the potential biases that may arise from these factors and have taken them into consideration when interpreting our results.

RQ2: How extensively do instructors of gateway courses utilize digital tools, and to what extent does their usage of digital tools change after participating in faculty development focused on effective teaching practices?

To respond to this research question, we will analyze the responses about the use of digital tools of a sample of 564 faculty who responded to these items during both the baseline and endpoint survey. Of this total, 412 are ACUE faculty and 152 are from the comparison group.

For the analysis of continuous variables—number of digital tools used, frequency of use of digital tools, number of courseware programs used, and perception of digital tools—we perform paired *t* tests. This statistical method was selected because it allows for the comparison of differences in average scores between two time points, in this case baseline and endpoint. By employing paired *t* tests, it is possible to assess any significant changes in the scores over time within subjects.

To investigate the differences in proportions between the ACUE group and the comparison group based on faculty current use of digital tools in different course formats (e.g., face-to-face, online), we employ chi-square tests. The chi-square test is appropriate to examine the association between categorical variables and assess significant differences in the distribution of frequencies between groups. By utilizing this test, we aim to determine whether there are any significant disparities in the frequencies of the variable of interest between the ACUE group and the comparison group.

By employing these statistical methods, we expect to gain insights into the changes in scores over time for continuous variables and assess group differences for frequency variables, thus providing a comprehensive evaluation of the use and perceptions of courseware/digital tools among ACUE faculty and comparison faculty.

RQ3: How aware are faculty of their institution's student success initiatives related to gateway courses, and how positively do they perceive these initiatives? To what extent do their awareness and attitudes change after participating in faculty development focused on effective teaching practices?

We address this research question by analyzing the data of a sample of 564 participants who responded to the institutional initiative items during the baseline and endpoint survey. Of this total, 412 participants are ACUE faculty and 152 are comparison faculty. We perform paired *t* tests to analyze awareness of institutional initiatives and attitudes toward institutional initiatives because it allows for the comparison of differences in average scores between two time points, in this case, baseline and endpoint. By employing paired *t* tests, it is possible to assess any significant changes in the scores over time within subjects.

RQ4: To what extent are students' self-efficacy and growth mindset influenced when faculty members engage in faculty development focused on effective teaching practices?

We perform paired *t* tests to compare students' retrospective perceptions with their perception at the time of taking the survey for growth mindset and academic self-efficacy. This statistical method was selected because it allows for the comparison of differences in average scores between two time points, in this case retrospective and current. By employing paired *t* tests, it is possible to assess any perceived significant changes within students over time. By employing this statistical method, we expect to gain insights into the perceived changes over time for continuous variables within each student.

RQ5: Do student reports show that faculty implemented the instructional practices they learned through faculty development? To what extent do students in gateway courses perceive that their instructors' utilization of digital tools and other instructional resources facilitated their learning?

We describe student reports of instructional practices, including the extent to which their instructor's use of digital tools and instructional resources helped them learn, by calculating the means and standard deviations obtained by the spring 2022 and fall 2022 samples, and by all the student data combined. We provide this descriptive data because it summarizes the overall magnitude and variability in the responses for these variables within the samples. By employing this statistical method, we expect to gain insights into the overall trends within the student sample.

RQ6: How positively do students in gateway courses perceive the campus climate, belonging, and efforts for student success?

We describe attitudes toward the institution's commitment with student success, campus climate, and sense of belonging by calculating the means and standard deviations obtained by the spring 2022 and fall 2022 samples, and by all the student data combined. We provide this descriptive data because it summarizes the overall magnitude and variability in the responses for these variables within the samples.

By employing this statistical method, we expect to gain insights into the overall trends within the student sample, thus providing a general evaluation of students' perceptions and attitudes toward their institution's initiatives and environment, and their connections with others in their courses.

RESULTS

We first present the results of the faculty-focused research questions and then move on to the results of the student-focused research questions.

RQ1: How effective is comprehensive faculty development focused on effective teaching practices at improving faculty self-efficacy and mindset?

Factor Analysis: Mindsets and Self-Efficacy Scales

Development of the Mindsets Scale and Subscales. To assess the construct validity and generalizability of the Mindsets Scale, we used a cross-validation approach by performing an exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) with two different samples. To create these two samples, we combined the total dataset from the baseline time point, including ACUE faculty and the comparison group, to form a single data pool (N = 1,071). Next, we randomly assigned participants from this pool to one of the two samples to ensure unbiased selection, minimize any potential systematic difference between the EFA and the CFA samples, and increase the validity of this study. The EFA sample had a total of 538 participants, while the CFA sample had 533 participants.

Following this, we conducted the EFA to explore the underlying factor structure of the Mindsets Scale. During an initial analysis, we identified that two of the items presented issues, such as cross-loading between two factors and poor factor loading (below .30); thus, these two items were dropped from the analysis. The EFA with the 16-item version of the Mindsets Scale employed principal axis factoring as the extraction method and promax rotation to allow the correlation of factors. The criterion for factor retention was eigenvalues greater than one. This EFA yielded a 5-factor structure, as shown in Table 4. The five factors showed good intercorrelations (KMO = .806) indicating that factor analysis is appropriate for further investigation (Kaiser, 1974). It was also confirmed through the Bartlett's Test of Sphericity,

$\chi^2(120) = 2333.456$, $p < .00$, that there are patterned relationships among the variables supporting the existence of underlying factors in the Mindsets Scale (Bartlett, 1950).

Subsequently, we performed the CFA with the other sample to validate the factor structure identified in the EFA and confirm the goodness-of-fit of the model. As recommended by Kline (2016), the goodness-of-fit indices selected suggested that the factor structure obtained from the EFA provides a reasonably good fit, $\chi2(108) = 331.104$, $p < .001$, CFI = .923, TLI = .903, RMSEA = .062, SRMR = .645, as CFI and TLI values above 0.90, and RMSEA and SRMR values below 0.08 generally suggests an acceptable fit. Although the chi-square test was statistically significant, it is important to consider this test is sensitive to sample size, with small discrepancies leading to significant results in the context of large samples. Additionally, this scale presented acceptable levels of internal consistency ($\alpha = .708$), with each of its factors also presenting acceptable levels with Cronbach's α scores ranging between .60 and 0.80.

Based on these results, the subsequent analyses in this study will treat the scores of the Mindsets Scale as a single measure, including the two dropped items mentioned previously ($\alpha = .711$) to ensure a more comprehensive assessment of the participants' attitudes. Additionally, each of the five factors identified through the factor extraction will be employed as separate subscales (excluding the problematic items). This approach allows for a more detailed examination of participants' beliefs and attitudes about teaching, providing a more comprehensive understanding of their changes across time points and the different aspects of this construct.

Development of the Self-Efficacy Scale and Subscales. To assess the construct validity and generalizability of the Self-Efficacy Scale, we used a cross-validation approach by performing an exploratory factor analysis (EFA) and a confirmatory factor analysis (CFA) with two different samples. Following the same process when creating the two samples for the Mindsets Scale analysis, we combined the total dataset from the baseline time point, including ACUE faculty and the comparison group, to form a single data pool ($N = 995$). Next, participants from this pool were randomly assigned to one of the two samples to ensure

unbiased selection, minimize any potential systematic difference between the EFA and the CFA samples, and increase the validity of this study. The EFA sample had a total of 495 participants while the CFA sample had 500 participants.

Following this, the EFA was conducted to explore the underlying factor structure of the Self-Efficacy Scale. To ensure data integrity and consistency, the seven items that had been distributed with varying wordings on the endpoint survey were excluded from the factor analysis to maintain the validity and reliability of the scale and to ensure that all participants were evaluated based on the same set of items. During an initial analysis, we identified that one of the remaining items was cross-loading between two factors; thus, this item was dropped from the analysis. The EFA with 22 items of the Self-Efficacy Scale employed principal axis factoring as the extraction method and promax rotation to allow the correlation of factors. The criterion for factor retention was eigenvalues greater than one. This EFA yielded a 3-factor structure, as shown in Table 5. The three factors showed good intercorrelations (KMO = .948) indicating that factor analysis is appropriate for further investigation (Kaiser, 1974). It was also confirmed through the Bartlett's Test of Sphericity, $\chi^2(231) = 5859.485$, $p < .00$, that there are patterned relationships among the variables supporting the existence of underlying factors in the Self-Efficacy Scale (Bartlett, 1950).

Subsequently, we performed the CFA with the other sample to validate the factor structure identified in the EFA and confirm the goodness-of-fit of the model. As recommended by Kline (2016), the goodness-of-fit indices selected suggested that the factor structure obtained from the EFA provides a reasonably good fit, $\chi2(194) = 448.956$, $p < .001$, CFI = .957, TLI = .948, RMSEA = .052, SRMR = .716, as CFI and TLI values above 0.90, and RMSEA and SRMR values below 0.08 generally suggests an acceptable fit. Although the chi-square test was statistically significant, it is important to consider this test is sensitive to sample size, with small discrepancies leading to significant results in the context of large samples. Additionally, this scale presented acceptable levels of internal consistency ($\alpha = .939$), with each of its factors also presenting good levels with Cronbach's α scores ranging between .82 and 0.92.

Based on these results, the subsequent analyses in this study will treat the scores of the Self-Efficacy Scale as a single measure, including the one dropped item mentioned previously (α = .941) to ensure a more comprehensive assessment of the participants' attitudes. Additionally, each of the three factors identified through the factor extraction will be employed as separate subscales (excluding the problematic items). This approach allows for a more detailed examination of participants' levels of self-efficacy with each of the practices learned throughout the ACUE course, providing a more comprehensive understanding of their changes across time points.

Although seven items had to be excluded from the factor analyses, all items originally designed to measure self-efficacy will be included in the analysis (α = .951) as appropriate, except for one of the items that presented issues due to multicollinearity with another item. This will ensure that the full content of the ACUE course is encompassed in the analysis.

Variance Components

Our linear multilevel model allows us to examine the sources of variation in faculty self-efficacy and mindsets. By decomposing the variance components, we can identify and model the differences that occur between institutions, between faculty within the same institutions, and within individual faculty over time. The results from the variance decomposition are presented in Table 6.

Regarding faculty self-efficacy, we find that approximately 51% of the total variation in self-efficacy can be attributed to differences observed between faculty members within the same institutions. On the other hand, only 4% of the total variance in self-efficacy reflects stable differences across institutions, indicating that there are limited differences in self-efficacy levels between institutions that persist over time. The remaining 45% of the variation in self-efficacy exists within faculty members across time, indicating that there are meaningful changes in self-efficacy over the analysis period.

Turning to faculty mindsets, we observe that approximately 63% of the total variance is attributable to differences observed between faculty members within the same institutions over time. Comparatively, 35% of the total variance in mindsets exists within individual faculty members across time. Additionally, 2% of the total variance reflects stable differences across institutions, indicating that there are limited persistent differences in mindsets between institutions that are not related to changes within faculty members.

The relatively large between-faculty variances for both self-efficacy and mindsets provide evidence in favor of using random effects to model the hierarchical structure of the survey data. Random effects modeling allows us to appropriately account for this variation at different levels and provides a more accurate representation of the data.

Changes in Self-Efficacy and Mindsets

One simple way to assess the impact of the ACUE certification on faculty self-efficacy and mindset is by comparing the raw means of these self-reported scales at different time points. However, these raw means alone would not fully account for the variation across individual faculty in their baseline levels of self-efficacy or mindset. To mitigate biases and more accurately assess the impact of the ACUE ETP course on self-efficacy and mindsets, we utilize a linear multilevel model capturing individual faculty changes over time. The results of the regression analysis are presented in Tables 7 and 8. We discuss the self-efficacy and mindset results separately, including their respective subscales.

Self-Efficacy. The multilevel model reveals that faculty self-efficacy increased by approximately 0.34 points during the midpoint relative to the baseline (Table 7, column 2). This corresponds to an increase from 3.64 to 3.98. From baseline to endpoint, faculty self-efficacy increased by approximately 0.60 points (M = 4.24), and from baseline to follow-up, it increased by approximately 0.48 points (M = 4.12). These results align with the trends observed in the raw means.

Table 7, columns 3–5 show the results from our analysis of self-efficacy separately by its three subscales: Clarity, Effective Teaching, and Adjustment. Clarity had the highest average baseline rating (*M* = 4), followed by Adjustment (*M* = 3.8) and Effective Teaching (*M* = 3.4). Across all self-efficacy subscales, there were consistent increases in faculty ratings relative to baseline. At midpoint, subscale ratings increased by 0.21 to 0.42 points. At the endpoint, the increases ranged from 0.35 to 0.74 points. Lastly, at the follow-up, subscale ratings increased by 0.29 to 0.59 points. Despite Clarity having the highest baseline rating, Effective Teaching showed the largest increases at each time point relative to baseline. Notably, the effect size observed at the endpoint was relatively larger compared to the midpoint and follow-up, indicating a more substantial impact on self-efficacy. Furthermore, while the follow-up period showed some attenuation in self-efficacy over time, the effect sizes observed during the follow-up were still larger compared to the midpoint.

Mindset. The multilevel model estimated that average faculty mindset ratings improved by approximately 0.07 points in the midpoint relative to the baseline (Table 8, column 2), resulting in an increase from 4.37 to 4.44. From baseline to both endpoint and follow-up, faculty mindset ratings improved by approximately 0.16 points (*M* = 4.53). These findings are consistent with the trends observed in the raw means on mindset ratings. They also suggest that the ACUE course had a sustained and more stable effect on mindset over time compared to the results observed for self-efficacy.

Table 8, columns 3–7 report the results for each of the five mindset subscales: Teaching Effectiveness, Personal Impact, Growth Mindset, Self-Improvement, and Enthusiasm. The results indicate that while there was a positive increase in each subscale rating at the midpoint, the effect sizes were statistically significant only for Teaching Effectiveness (*b* = 0.11), Self-Improvement (*b* = 0.19), and Enthusiasm (*b* = 0.05). The smaller increase in Enthusiasm compared to Teaching Effectiveness and Self-Improvement could be partly due to Enthusiasm starting at a higher average rating (*M* = 4.63). From the baseline to the endpoint, there was a significant increase in all mindset subscale ratings, except for Growth Mindset (*b* = 0.09; *p* = 0.123). The significant increases ranged from 0.05 to 0.38 points. Additionally, at the

follow-up, there was a significant increase in all subscale ratings, ranging from 0.06 to 0.35 points. Self-Improvement had the lowest average rating at baseline (*M* = 4.07) among all mindset subscales, and it demonstrated the largest increases across all time points.

Overall, the results suggest that the ACUE certification had a positive impact on both faculty self-efficacy and mindset. The increase in self-efficacy was consistent across various subscales, with notable gains observed in effective teaching. Mindset also demonstrated improvement, although with smaller magnitudes compared to self-efficacy. The sustained effect on mindset over time indicates a positive influence from the course. Importantly, the endpoint ratings for all self-efficacy and mindset subscales reached average scores above 4, indicating positive shifts in faculty perceptions.

The results suggest that the ACUE certification had a positive impact on both faculty self-efficacy and mindset.

Robustness Tests. To ensure the robustness of our linear multilevel model, we examined our assumption that faculty self-efficacy and mindsets would have remained relatively stable over time and that there were no concurrent shocks to these outcomes. We employed a differences-in-differences (DID) approach to compare changes over time between ACUE faculty and a group of faculty who taught gateway courses but did not participate in the ACUE course (comparison faculty). We did not adopt the DID specification as our primary specification due to potential biases caused by the changing composition of comparison faculty over time.

Table 9 displays the results from the DID specification. The results were largely similar to our main results. For self-efficacy (Table 9, columns 1–4), the interactions between ACUE and time were significant at each time point, although the point estimates differed slightly. Some notable differences between model estimates were observed in the subscales, particularly a larger effect of ACUE on Clarity at the endpoint (0.41 in the DID specification vs. 0.35 in the

primary specification). The largest change was observed in Effective Teaching at the endpoint, where the point estimate decreased from 0.74 to 0.64.

For mindset (Table 9, columns 5–10), results were again similar between the two models, with slight variations in point estimates. Notably, the effect of ACUE on Enthusiasm was more than three times larger in the DID specification compared to the primary specification. This would suggest that ACUE increased participants' Enthusiasm by 0.15 points from baseline to endpoint. The larger magnitude is, in part, attributed to the statistically significant decline in comparison faculty's self-reported Enthusiasm between the baseline and endpoint (b = -0.095; $p < 0.05$).

Considering the missingness in the comparison group, we further restricted our sample to ACUE and comparison faculty who responded to surveys in all four time points. Similar results were obtained for self-efficacy and its subscales (see Table 10). For mindset, most results remained qualitatively similar, but previous significant effects disappeared for Personal Impact and Growth Mindset. It is important to exercise caution when interpreting estimates from this model due to the small sample size, which included approximately 1,054 observations across 88 comparison faculty and 177 ACUE participants. All considered, the DID specification provides evidence in support of the assumption of stable changes over time in the absence of ACUE.

RQ2: How extensively do instructors of gateway courses utilize digital tools, and to what extent does their usage of digital tools change after participating in faculty development focused on effective teaching practices?

Use of Digital Tools

Through the survey, faculty were asked to indicate the digital tools they generally used in their gateway courses by providing different options. At baseline, the average number of digital tools used by the ACUE faculty was 2.99 (SD = 1.62), while at the endpoint the average

was 1.59 (SD = 1.98). The average number of digital tools used among ACUE faculty was significantly higher at baseline than at the endpoint, $t(411) = 11.974$, $p < .001$. Comparison faculty used an average of 2.82 (SD = 1.65) digital tools at baseline and an average of 2.35 (SD = 1.65) at the endpoint, with significantly higher scores at baseline, $t(151) = 3.752$, $p < .001$. Table 11 shows the proportion of the ACUE faculty and the comparison faculty using each of the options provided at each time point.

Current Use of Digital Tools by Format

Faculty were also asked about their current use of digital tools in different course formats, including face-to-face and online/hybrid formats. There is no significant difference between the ACUE faculty and the comparison faculty in the proportions of the current use of digital tools at baseline, $\chi2(3) = 0.1503$, $p = .985$, or at the endpoint, $\chi2(3) = 4.9445$, $p = .176$ (see Figure 14).

Frequency of Use of Digital Tools

Faculty were asked to report the frequency of their digital tool usage. The response options were coded as a 5-point Likert with the following options: *Never*, *Rarely (once a month or less)*, *Occasionally (2 or 3 times per month)*, *Regularly (about once a week)*, and *Very frequently*. At baseline, the average response by the ACUE faculty was 3.91 (SD = 1.32), and at endpoint their average frequency of usage reported was also 3.91 (SD = 1.33), $t(404) = 0.369$, $p = .713$. The average frequency of usage of digital tools of the comparison group at baseline was 3.95 (SD = 1.34) and at endpoint the average was 3.90 (SD = 1.33), $t(144) = 0.642$, $p = .522$. The average frequency reported for the two groups combined was 3.92 (SD = 1.33).

Use of Digital Courseware Programs

Faculty were asked about their use of specific digital courseware programs by providing different options. At baseline, the average number of courseware programs used by the ACUE

faculty was 0.72 (*SD* = 0.61) and at the endpoint their average was 0.39 (*SD* = 0.61), $t(411) = 8.125$, $p < .001$. In the case of the comparison faculty, their average number of courseware programs used at baseline was 0.65 (*SD* = 0.78) and at the endpoint was 0.58 (*SD* = 0.59), $t(151) = 1.348$, $p = .180$. Table 12 shows the proportion of the ACUE faculty and the comparison faculty using each of the options provided at each time point.

Perception of Digital Tools as Instructional Resources

Faculty were asked to rate how much they considered digital tools as valuable instructional resources. The response was presented as a 4-point Likert scale that ranged from 1 (*not at all*) to 4 (*very much*). The average response of the ACUE group at baseline was 3.48 (*SD* = 0.67) and at the endpoint was 3.51 (*SD* = 0.68), $t(401) = -0.606$, $p = .545$. In the case of the comparison group, the average response at baseline was 3.35 (*SD* = 0.82) and at the endpoint was 3.30 (*SD* = 0.79), $t(550) = -0.214$, $p = .499$. The overall average for the ACUE group was 3.50 (*SD* = 0.68) and for the comparison group it was 3.33 (*SD* = .81).

RQ3: How aware are faculty of their institution's student success initiatives related to gateway courses, and how positively do they perceive these initiatives? To what extent do their awareness and attitudes change after participating in faculty development focused on effective teaching practices?

Perception of the Project as Part of Institution's Gateway Course Initiatives

Only ACUE faculty were asked to agree or disagree about the importance of the project with the Gates Foundation and ACUE as a part of their institution's gateway courses initiatives. The response was presented as a 5-point Likert scale that ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). The ACUE faculty had a response average of 3.97 (SD = 1.05) at baseline and an average of 4.01 (SD = 1.23) at endpoint, $t(298) = -1.034$, $p = .302$.

Additionally, participants were given the option "I do not know if or how this project fits in with my institution's broader initiatives." At baseline, 21.7% of the ACUE faculty selected this option, while at endpoint, 9.3% of the participants did.

Attitudes Toward the Effectiveness of Institution's Initiatives

All faculty were surveyed regarding their feelings about the effectiveness of their institution's initiatives focused on gateway courses. The response was presented as a 5-point Likert scale ranging from 1 (*very negative*) to 5 (*very positive*). At baseline, the average response of the ACUE group was 3.84 (SD = 1.02) and at the endpoint the average response was 4.04 (SD = 1.00). Statistical analysis reveals that there is a significant difference between the average scores at baseline and endpoint among ACUE faculty, $t(323) = -3.367$, $p < .001$. In the case of the comparison faculty, the average response at baseline was 3.58 (SD = 1.10) and at endpoint was 3.61 (SD = 1.10), with no significant differences between baseline and endpoint average scores, $t(123) = 0.624$, $p = .534$.

In addition, participants were given the option "N/A; my institution does not have any initiatives focused on gateway courses, or I am not sure if they have any initiatives focused on gateway courses." At baseline, 14.1% of the ACUE faculty selected this option, while 12.6% of the comparison faculty did. At the endpoint, 10% of the ACUE faculty selected this option, while 10.5% of the comparison faculty did.

RQ4: To what extent are students' self-efficacy and growth mindset influenced when faculty members engage in faculty development focused on effective teaching practices?

Growth Mindset

Students reported their growth mindset, comparing how they felt at the beginning of the semester (retrospectively) and at the time of taking the survey (currently). Responses were presented as a 5-point Likert scale ranging from 1 (*strongly agree*) to 5 (*strongly disagree*), with higher scores representing greater growth mindset. Spring 2022 students reported that they had greater growth mindset at the end of the semester (M = 3.80, SD = 1.14) than they did at the beginning of the semester (M = 3.58, SD = 1.12), $t(955) = -9.686$, $p < .001$. The same pattern occurs for the fall 2022 group, with students reporting that they had greater growth mindset at the end of the semester (M = 3.60, SD = 1.16) than they had at the beginning of the semester (M = 3.45, SD = 1.11), $t(1845) = -9.250$, $p < .001$ (see Figure 15).

Academic Self-Efficacy

Students were asked to reflect on their confidence levels in "Communication" and "Self-Monitoring," by comparing how they felt at the beginning of the semester (retrospectively) and at the time of taking the survey (currently). The response options were presented as a 5-point Likert ranging from 1 (*not at all confident*) to 5 (*extremely confident*).

Spring 2022 students reported that they had greater self-efficacy in their communication at the end of the semester (M = 3.84, SD = 1.01) than they did at the beginning of the semester (M = 3.16, SD = 1.12), $t(957) = -22.364$, $p < .001$. The fall 2022 group shows the same pattern, with students reporting that they had greater self-efficacy in their communication at the end of the semester (M = 3.53, SD = 1.12) than at the beginning of the semester (M = 3.01, SD = 1.11), $t(1859) = -23.841$, $p < .001$ (see Figure 16).

Similarly, spring 2022 students reported that they had greater self-efficacy in their self-monitoring at the end of the semester (M = 4.04, SD = 0.90) than they did at the beginning of the semester (M = 3.51, SD = 1.00), $t(959) = -18.534$, $p < .001$. The same pattern is observed with the fall 2022 group, with students reporting that they had greater self-efficacy in their self-monitoring at the end of the semester (M = 3.92, SD = 0.91) than at the beginning of the semester (M = 3.51, SD = 0.94), $t(1860) = -19.823$, $p < .001$ (see Figure 17).

RQ5: Do student reports show that faculty implemented the instructional practices they learned through faculty development? To what extent do students in gateway courses perceive that their instructors' utilization of digital tools and other instructional resources facilitated their learning?

Through the survey, students were asked to indicate their level of agreement on whether their instructors implemented various instructional practices, such as actively engaging students, explaining the rationale for activities and assignments, and providing helpful feedback, among others. The responses were presented as a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The spring 2022 sample had an average response of 4.44 (SD = 0.70), and the fall 2022 sample had an average response of 4.22 (SD = 0.80). The overall average combining the two student samples is 4.30 (SD = 0.78).

Students were also asked whether their instructors' use of instructional resources (e.g., textbooks, online collaboration tools) helped them learn. Spring 2022 students had an

average response of 4.44 (*SD* = 0.79) and fall 2022 students had an average of 4.22 (*SD* = 0.92). The overall average combining the two student samples is 4.30 (*SD* = .88).

Additionally, students were asked about whether their instructors' use of technology tools, such as surveys and discussion boards, among others, helped them learn. Spring 2022 students had an average response of 4.38 (*SD* = 0.86) and fall 2022 students an average of 4.14 (*SD* = 0.96). The overall average combining the two student samples is 4.22 (*SD* = .93).

Finally, students were also asked about whether their instructors' use of digital courseware (e.g., OpenStax, Acrobatiq) helped them learn. The spring 2022 sample had an average response of 4.23 (*SD* = 0.91) and the fall 2022 sample had an average of 4.01 (*SD* = 0.96). The overall average combining the two student samples is 4.09 (*SD* = .95).

RQ6: How positively do students in gateway courses perceive the campus climate, belonging, and efforts for student success?

Campus Climate

Students were asked to indicate their level of agreement with statements regarding campus climate. The responses were presented as a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The average response of the spring 2022 group was 3.42 (*SD* = 0.65) and the average response of the fall 2022 group was 3.41 (*SD* = 0.68). The overall average combining the two student samples is 3.41 (*SD* = .67).

Sense of Belonging

Finally, students were asked to indicate their perceptions of their social connections and relationships they have with their peers in their course section. The responses were presented as a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). The average response of the spring 2022 sample was 3.89 (*SD* = 0.80) and the average response of the fall

2022 group was 3.88 (*SD* = 0.77). The overall average score combining the two student samples is 3.88 (*SD* = .78).

Attitudes Toward Student Success Efforts

Students were asked about their perceptions of their institution's commitment to their academic success. Responses were presented as a 5-point Likert scale ranging from 1 (*strongly disagree*) to 5 (*strongly agree*). Spring 2022 students had an average response of 4.25 (*SD* = 0.79), while fall 2022 students had an average response of 4.18 (*SD* = 0.85). The overall average combining the two student samples is 4.21 (*SD* = .83).

Similarly, students were also assessed on their awareness of their institution's initiatives to improve student success, with 88% of the students reporting at least some awareness. Table 13 describes in detail the proportion of the responses given by the two student samples.

DISCUSSION AND CONCLUSION

Discussion

For faculty teaching gateway courses, the findings from the linear multilevel model highlight the effectiveness of comprehensive faculty development in promoting positive shifts in faculty self-efficacy and mindsets. The examination of self-efficacy revealed consistent improvements across all time points, with effect sizes ranging from medium (*d* = 0.61 at midpoint) to very large (*d* = 1.21 at endpoint). This means that the course had an important positive impact on faculty members' self-efficacy. Furthermore, analyses of sub-scales showed improvements across all dimensions of self-efficacy—effective teaching practices, adjusting instruction, and clarity in instruction—with a particularly strong impact on faculty's self-efficacy in implementing effective teaching practices. In other words, faculty became more confident in their ability to implement effective, evidence-based teaching practices in the classroom or online, including engaging and motivating students, facilitating discussions,

and integrating active learning into their lessons. They also became more self-assured in their ability to adjust their instruction considering student understanding, achievements, and feedback. Likewise, they enhanced their confidence in their ability to provide clear explanations and directions to their students. The positive effect observed at follow-up indicates the potential long-term benefits of the course in promoting self-efficacy among faculty members.

The ACUE course also led to significant improvements in faculty mindsets. There was a sustained and stable effect on average mindset ratings over time, with effect sizes ranging from small (d = 0.22 at midpoint) to medium (d = 0.51 at endpoint). This indicates that comprehensive faculty development had a noticeable positive influence in their mindsets. The positive increases in all mindset subscales—perceived teaching effectiveness, impact of instruction on students, growth mindset, teaching improvement behaviors, and teaching enthusiasm—particularly in the follow-up period, indicate a holistic transformation in faculty perceptions and attitudes towards students, teaching, and learning. The overall improvements observed across all dimensions of mindsets indicate that the course had a positive and sustained influence on faculty members' perception of their teaching effectiveness, awareness of the influence their teaching has on students' learning, growth mindset, adoption of teaching improvement behaviors, and their enthusiasm for teaching.

Taken together, the faculty and student survey results not only support the hypothesis that comprehensive faculty development improves faculty's mindsets and self-efficacy, but also suggests that these mindset and self-efficacy shifts play out among students as well.

The robustness tests employing a differences-in-differences (DID) approach confirmed the main results, supporting the primary hypothesis that comprehensive faculty development is associated with improvements in

faculty's mindsets and self-efficacy. The minor differences in the estimates between the primary model and the DID specification further strengthen the reliability of the findings.

Student survey data offers some insight into how the changes in faculty self-efficacy and mindset impacted the student course experience. First, the relatively high average scores on the Instructional Practices Scale of the student survey in both the fall and spring 2022 semesters confirms that the ACUE faculty implemented the practices they were learning. Importantly, analysis of the student survey demonstrated that students across both semesters perceived a significant increase in their growth mindset and academic self-efficacy from the start of the semester to the end of the semester. Since only students of ACUE faculty completed the student survey, we cannot compare these changes to those otherwise occurring in students enrolled in gateway courses at these institutions. However, the retrospective pre/post results on students' self-efficacy and growth mindset do suggest that ACUE faculty positively influenced their students' mindsets.

Taken together, the faculty and student survey results not only support the hypothesis that comprehensive faculty development improves faculty's mindsets and self-efficacy, but also suggests that these mindset and self-efficacy shifts play out among students as well. Given the research linking students' self-efficacy and growth mindset to their achievement (e.g., Gore, 2006; Multon et al., 1991; Robins & Pals, 2022), we would expect these changes in faculty and student self-efficacy mindsets to be followed by improvements in students' course performance, as shown in the model in Figure 18. Furthermore, the significant effects one semester after the end of the ACUE course, particularly on faculty mindsets, demonstrate the sustained impact of comprehensive faculty development and the potential for faculty certified in this framework of effective teaching to impact students for semesters to come. The trends in faculty self-efficacy and mindsets over time also support the notion that comprehensive faculty development can simultaneously impact faculty mindsets and improve use of effective teaching practices, rather than faculty mindset changes being a prerequisite for successfully engaging in faculty development.

Additional exploratory research on faculty found ACUE faculty's attitudes toward the effectiveness of their institution's initiatives focused on gateway courses became significantly more positive from baseline to the end of their ACUE course, while the attitudes of the comparison group toward these initiatives remained constant over the same period. This pattern may suggest that participation in comprehensive faculty development gave faculty more connection and insight into the institution's overall student success efforts, or perhaps that the ACUE faculty specifically perceived the ACUE course as a valuable and constructive part of their institution's efforts to improve gateway courses. Student survey results also indicated that students reported positive attitudes toward their institution's commitment to student academic success, as well as moderately positive attitudes about their campus climate and a moderately positive sense of belonging.

Additionally on the topic of digital tools, most faculty from both groups (approximately 70%) reported using digital tools in all course formats. Results also showed a general decrease in the number of digital tools used over time within both the ACUE group and the comparison group, although the perception of these tools as valuable instructional resources remained consistent across the two time points evaluated. Similarly, the high average scores on the items related to digital tools and instructional resources demonstrates that students perceived their instructors' use of these tools as contributing to their learning.

Both the primary and additional research questions generated meaningful new insights from faculty teaching gateway courses and students enrolled in gateway courses at 2- and 4-year institutions across the country. While the current study focused specifically on ACUE's Effective Teaching Practice Framework Certification, the findings may apply to faculty development broadly, so long as faculty development programs are comprehensive, meaning that they address pedagogical knowledge and skills and also use a learning design that supports changes in self-efficacy and mindset, such as through expectations to implement recommended practices and reflect on the student impact and areas for refinement. As such, these results contribute to the existing literature on faculty development and have

implications for higher education institutions aiming to support student success with initiatives that center faculty and enhance teaching effectiveness.

Limitations

There are several potential limitations to this study to consider. One limitation is the use of a quasi-experimental design rather than a randomized controlled trial (RCT). The lack of random assignment to the ACUE course and the comparison group introduces the possibility of selection bias. While efforts were made to mitigate potential biases, such as using a longitudinal framework to compare faculty with themselves over time, it is important to acknowledge that factors beyond the ACUE course may have influenced the observed changes in faculty self-efficacy and mindsets. Robustness tests provide support for our assumption of stable changes over time in absence of the ACUE course, but future research might employ a randomized design to provide stronger evidence of causality and enhance the internal validity of the findings.

Second, the comparison group has a changing composition over time. We collected survey data from both ACUE participants and comparison faculty at multiple time points. However, missing data and nonresponse bias is of particular concern with our comparison group, limiting our use of the comparison data in the primary specification. In the DID specification, the changing composition of the comparison group over time introduces the possibility of confounding variables and limits the ability to draw causal inferences. Future research should aim to minimize missingness and nonresponse bias through strategies such as incentivizing participation and employing even more rigorous data collection procedures.

A third potential limitation derives from the reliance on self-reported data for measuring faculty self-efficacy and mindsets. Self-reported measures are subject to social desirability bias, where participants may provide responses that they believe are more favorable or expected. This bias could lead to inflated perceptions of self-efficacy and mindsets, potentially overestimating the impact of the ACUE course. To mitigate this impact, survey instructions

were written to encourage honest responses and emphasize that there are no “right” answers.

Another potential limitation of this study relates to the development and administration of the Self-Efficacy Scale. Due to an error, different versions of scale items were distributed to participants, leading to the exclusion of seven problematic items from the factor analysis. This could have affected the accuracy in which some of the practices taught in the course could have been evaluated, limiting the scale’s comprehensive representation of the ACUE course content.

Conclusions that can be drawn from the student surveys are limited due to the lack of a comparison group and use of a retrospective pre/post design for self-efficacy and growth mindset. Future research could examine changes over time by surveying students at the beginning and end of the semester and including a comparison group of students taught by faculty who are not participating in comprehensive faculty development. Another limitation of the student survey data analysis was the insufficient response rate for the spring 2023 semester. Despite collecting data from student surveys at the end of the spring 2022, fall 2022, and spring 2023 semesters, the number of responses received for the spring 2023 semester was not sufficient for performing meaningful analysis. Therefore, the findings and conclusions for the student data were restricted only to the data collected from the spring 2022 and fall 2022 semesters, limiting the comprehensive understanding of student trends.

Lastly, as with any study conducted in a specific context, the generalizability of the findings may be limited. The research was conducted across 10 U.S. colleges and universities, which were specifically chosen because of their diverse characteristics, in terms of geography, institution type, and student populations. However, these schools still may not be representative of all higher education institutions. Institutional and contextual factors, such as faculty and student demographics, institutional support, and curriculum structure, may influence the effectiveness of faculty development programs. Therefore, caution should be exercised when generalizing the findings to other institutions or populations, specifically to

institutions that differ from those included in this study. Future research could aim to replicate the study in a larger, more diverse setting to enhance the external validity and generalizability of the results.

Despite these limitations, this study provides valuable insights into the impact of comprehensive faculty development on self-efficacy and mindsets. The findings contribute to the existing literature on faculty development and highlight the importance of enhancing teaching practices and fostering a growth-oriented mindset among faculty members. Future research should address these limitations and build upon this study's findings to further advance the understanding of effective faculty development strategies in higher education.

Future Research

One fruitful area of future research would be to investigate the effect of faculty's improved self-efficacy and mindsets on student course outcomes. By examining student course performance (e.g., grades and completion rates) in conjunction with in-depth data on faculty mindsets and self-efficacy, we can more fully assess the extent to which comprehensive faculty development programs influence teaching effectiveness and student learning. This line of inquiry would shed light on the potential ripple effects of faculty self-efficacy and mindsets on student success and provide valuable insights for institutions aiming to improve student outcomes.

The increases observed in self-efficacy and mindsets underscore the importance of targeted faculty development initiatives in promoting effective teaching practices and fostering a growth-oriented mindset among faculty members.

Future research could also delve into the specific components or mechanisms within the ACUE course that contribute to improved faculty self-efficacy and mindsets. By conducting in-depth analyses of course modules, activities, and instructional strategies, we might identify the elements that have the most substantial impact on faculty perceptions. This knowledge would inform the design and refinement of faculty development programs, enabling institutions to optimize the delivery of interventions that foster positive shifts in faculty self-efficacy and mindsets.

Understanding the long-term effects and sustainability of comprehensive faculty development is another important avenue for future research. Tracking faculty participants beyond the study period examined in this research would provide insights into the durability of the observed changes in self-efficacy and mindsets. This would be particularly valuable to explore given that effects on some aspects of mindset did not become significant until the follow-up period, while impacts on confidence seemed to diminish somewhat by the follow-up period. Future studies could also explore the extent to which faculty continue to use the practices they implemented during their course and implement additional practices they learned in the semesters after they are certified. Examining these sustained patterns of implementation could help researchers understand the pattern of results in the follow-up period that we observed in the current study.

Conclusion

In conclusion, the findings of this study support the effectiveness of comprehensive faculty development, involving implementation of effective teaching practices and reflection on that implementation, in enhancing faculty self-efficacy and mindsets. The findings also provide preliminary evidence of positive impacts on student academic self-efficacy and growth mindset. The increases observed in these constructs underscore the importance of targeted faculty development initiatives in promoting effective teaching practices and fostering a growth-oriented mindset among faculty members.

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TABLES AND FIGURES

Tables

Table 1

Number of Participants Who Responded to only 1, 2, 3, or 4 Surveys

	Faculty type	
No. of surveys responded	ACUE	Comparison
1	96	635
2	52	230
3	246	106
4	177	91
Total participants	571	1,062

Table 2

Descriptive Statistics of Faculty Survey Respondents

Characteristic	ACUE Faculty	Comparison Faculty
Gender		
Female	0.64	0.55
Male	0.32	0.37
Other	0.04	0.08
Race/Ethnicity		
Asian	0.14	0.08
Black	0.14	0.09
Hispanic	0.08	0.07
Other	0.12	0.14
White	0.52	0.62
Tenure Status		
Tenure Track	0.34	0.35
Nontenure Track	0.59	0.56
Other	0.07	0.09
Years of Experience		
0–4 years	0.19	0.21
5–9 years	0.27	0.14
10–14 years	0.21	0.21
15–19 years	0.14	0.16
20 or more years	0.19	0.28
Teaching Format		
Face-to-face	0.14	0.17
Hybrid	0.01	0.01
Online	0.08	0.10
Mix	0.77	0.72
Discipline		
STEM	0.27	0.27
Non-STEM	0.73	0.73
Total Faculty	568	951

Note. The following statistics derive from the analytic sample used for the linear multilevel model. All values in this table, other than "Total Faculty," are expressed in decimal form, with the understanding that they represent percentages (e.g., .65 = 65%).

Table 3

Bill and Melinda Gates Foundation Gateway Course List

Gateway Courses
Introductory Accounting
Macroeconomic Principles
Introductory Business Finance
Microeconomic Principles
Marketing Principles
Introductory English Comp
Introductory Psychology
U.S. History (all periods)
American Government or Politics
Introductory Sociology
Calculus (single and multivariable)
Introductory Probability and Statistics
College Algebra
Liberal Arts Math
Precalculus
Introductory Computer Science
Introductory or General Biology
Introductory or General Chemistry
Introductory Physics
Introductory Anatomy and Physiology

Table 4

EFA Loadings for the Mindsets Scale

Items	F1	F2	F3	F4	F5
Factor 1: Perceived Teaching Effectiveness (α = .773)					
I am confident that I can help students learn.	.940				
I am confident in my ability to teach effectively.	.839				
I believe my teaching makes a difference in students' growth and development.	.415				
Overall, students are receptive to the teaching methods I use.	.362				
Factor 2: Impact of Instruction on Students (α = .641)					
I can influence how students perceive their intelligence.		.763			
My instructional choices have an impact on how students perform in my courses.		.608			
Teaching students how to reflect on and improve their learning is part of my role as an instructor.		.465			
I adjust my teaching based on student responses to activities, assignments, and assessments.		.334			
I believe my students can significantly grow and improve their abilities.		.301			
Factor 3: Growth Mindset (α = .800)					
Your intelligence is something about you that you can't change very much.			.837		
To be honest, students have a certain amount of intelligence, and they really can't do much to change it.			.832		
Factor 4: Teaching Improvement Behaviors (α = .610)					
I frequently take steps to become a better instructor.				.735	
I use current educational research to inform my teaching.				.606	
I often talk with colleagues about teaching.				.564	
Factor 5: Teaching Enthusiasm (α = .682)					
Working with students is one of the most enjoyable aspects of my job.					.958
I am enthusiastic about teaching.					.589
Items excluded from the factor analysis					
All students can be successful in my course.					
It is important to help students believe they can change their basic intelligence.					

Note. N = 533. Only factor loadings of .30 or higher were included. Full scale α = .708.

Table 5.

EFA Loadings for the Self-Efficacy Scale

Items	F1	F2	F3
Factor 1: Effective Teaching Practices (α = .920)			
Engaging quiet students in classroom and online discussions	.768		
Motivating students who show low interest in course activities and assignments	.757		
Avoiding and effectively addressing microaggressions and stereotype threats	.739		
Managing dominant talkers during classroom and online discussions	.708		
Managing disruptive behavior in my class or online course environment	.705		
Ensuring the majority of students engage in and learn from classroom and online discussions	.670		
Using varied questioning techniques to prompt critical thinking	.631		
Impacting students' beliefs about their ability to do well on course assignments and assessments	.602		
Teaching effective note-taking skills	.597		
Leading a successful first day (or first week for an online course) that builds community and helps students understand course expectations	.569		
Using the Active Learning Cycle	.552		
Developing students into lifelong learners	.537		
Using groups to ensure active learning	.481		
Planning an effective start, middle, and ending for a class session or online module	.468		
Delivering lectures that are paced to keep students engaged	.463		
Factor 2: Adjusting Instruction (α = .827)			
Using student achievement on assignments and assessments to inform instructional improvements		.955	
Using student feedback to inform instructional improvements		.720	
Checking for students' understanding and making appropriate adjustments to instruction		.498	

Effectively using available instructional resources (e.g., textbooks, learning management system, online collaboration tools) to maximize student learning	.412
Factor 3: Clarity in Instruction (α = .839)	
Providing clear explanations and examples for complex ideas or concepts	.904
Providing clear directions for complex procedures and processes	.832
Using visual tools to help students understand complex ideas, concepts, and procedures	.591
Items excluded from the factor analysis	
*Ensuring students use my feedback to improve their performance**	
Writing learning outcomes that are specific, student-centered, and actionable. (Alternative wording: Developing course outcomes and learning objectives that are learner-centered, meaningful, and measurable)	
Ensuring all assessments are aligned with my course learning outcomes (Alternative wording: Designing assessments and assignments aligned with course learning outcomes)	
Ensuring all course activities and assignments are aligned with my course outcomes (Alternative wording: Ensuring learning experiences are aligned with course outcomes)	
Creating a syllabus that both communicates essential information and facilitates student success (Alternative wording: Creating a syllabus that is inclusive and increases student engagement)	
Developing fair and consistent grading practices that students fully understand (Alternative wording: Using grading practices to increase accuracy, motivation, and equity)	
*Ensuring my grading practices are fair, consistently applied, and easily understood by students** (Alternative wording: Ensuring students understand my grading practices)*	
Providing students a clear understanding of my assignment expectations (Alternative wording: Using checklists and rubrics to clarify expectations, provide meaningful feedback, and increase equity)	

Note. N = 500. Only factor loadings of .30 or higher were included. Full scale α = .939.
*Item excluded from the factor analysis due to cross-loadings.
**Item excluded from the original version of the Self-Efficacy scale due to multicollinearity.

Table 6

Variance Decomposition of Faculty Self-Efficacy and Mindsets

	Self-Efficacy		Mindset	
	Variance	Proportion of Total Variance	Variance	Proportion of Total Variance
Between Institutions (ICC)	0.012	0.044	0.002	0.018
	(.009)		(0.001)	
Between Faculty (ICC)	0.139	0.511	0.068	0.631
	(.008)		(0.003)	
Within Faculty	0.121	0.445	0.038	0.351
	(.012)		(0.002)	

Table 7

ACUE and Changes in Faculty's Self-Efficacy

			Subscales		
	(1) Self-Efficacy	(2) Self-Efficacy	(3) Clarity	(4) Effective Teaching	(5) Adjustment
Midpoint	0.338***	0.340***	0.206***	0.421***	0.240***
	(0.038)	(0.037)	(0.041)	(0.043)	(0.037)
Endpoint	0.600***	0.603***	0.351***	0.740***	0.495***
	(0.030)	(0.029)	(0.037)	(0.037)	(0.020)
Follow-up	0.476***	0.477***	0.294***	0.585***	0.428***
	(0.034)	(0.036)	(0.055)	(0.037)	(0.037)
Covariates	No	Yes	Yes	Yes	Yes
Mean dependent variable	3.635	3.635	4.007	3.418	3.835
n(Observations)	1,558	1,554	1,550	1,551	1,548
n(Faculty)	570	568	568	568	568

Note. ** $p < .05$, *** $p < 0.01$. In the table above, columns 1–5 display results from individual regression analyses. The "Mean dependent variable" signifies the average reported response within the analytic sample at baseline. The coefficient estimates, presented as the point change from the mean dependent variable, are accompanied by their corresponding standard errors (enclosed in parentheses) reported below.

Table 8

ACUE and Changes in Faculty's Mindset

	(1) Mindset	(2) Mindset	Subscales (3) Perceived Effectiveness	(4) Personal Impact	(5) Growth Mindset	(6) Self-Improvement	(7) Enthusiasm
Midpoint	0.070***	0.071***	0.105***	0.020	0.012	0.191***	0.054**
	(0.016)	(0.015)	(0.013)	(0.023)	(0.023)	(0.034)	(0.021)
Endpoint	0.162***	0.162***	0.219***	0.110***	0.085	0.377***	0.046**
	(0.019)	(0.019)	(0.018)	(0.028)	(0.055)	(0.031)	(0.020)
Follow-up	0.161***	0.161***	0.208***	0.065**	0.137***	0.351***	0.055***
	(0.023)	(0.023)	(0.033)	(0.026)	(0.043)	(0.034)	(0.020)
Covariates	No	Yes	Yes	Yes	Yes	Yes	Yes
Mean Dep. Var.	4.369	4.369	4.360	4.572	4.075	4.072	4.633
n(Observations)	1,641	1,635	1,629	1,635	1,634	1,629	1,629
n(Faculty)	572	569	568	569	569	568	568

Note. ** $p < .05$, *** $p < 0.01$. In the table above, columns 1–7 display results from individual regression analyses. The "Mean dependent variable" signifies the average reported response within the analytic sample at baseline. The coefficient estimates, presented as the point change from the mean dependent variable, are accompanied by their corresponding standard errors (enclosed in parentheses) reported below.

Table 9

Changes in Faculty's Self-Efficacy and Mindset (DID Specification)

		Subscales				Subscales				
	(1) Self-Efficacy	(2) Clarity	(3) Effective Teaching	(4) Adjustment	(5) Mindset	(6) Perceived Effective	(7) Personal Impact	(8) Growth Mindset	(9) Self-Improvement	(10) Enthusiasm
ACUE	-0.239***	-0.226***	-0.275***	-0.242***	-0.042**	-0.114***	-0.012	0.010	-0.120***	0.007
	(0.031)	(0.025)	(0.034)	(0.051)	(0.021)	(0.031)	(0.011)	(0.034)	(0.042)	(0.025)
Midpoint	0.003	-0.012	0.011	-0.021	-0.004	0.009	-0.039	-0.030	-0.051	-0.009
	(0.024)	(0.034)	(0.026)	(0.039)	(0.018)	(0.021)	(0.021)	(0.033)	(0.027)	(0.024)
Endpoint	0.065**	-0.056	0.101***	0.006	0.002	0.015	-0.007	0.023	0.035	-0.105
	(0.030)	(0.034)	(0.028)	(0.039)	(0.025)	(0.021)	(0.023)	(0.048)	(0.043)	(0.022)
Follow-up	0.055	0.010	0.056**	0.049	0.005	-0.001	-0.006	-0.022	0.083**	-0.039
	(0.030)	(0.047)	(0.027)	(0.042)	(0.021)	(0.030)	(0.011)	(0.054)	(0.033)	(0.029)
ACUE*Mid	0.333***	0.214***	0.405***	0.258***	0.075***	0.097***	0.058	0.044	0.243***	0.064**
	(0.043)	(0.049)	(0.048)	(0.055)	(0.017)	(0.014)	(0.037)	(0.040)	(0.034)	(0.029)
ACUE*End	0.535***	0.408***	0.638***	0.489***	0.161***	0.204***	0.117***	0.063	0.342***	0.152***
	(0.051)	(0.057)	(0.058)	(0.048)	(0.018)	(0.014)	(0.028)	(0.084)	(0.030)	(0.037)
ACUE*Follow	0.425***	0.286***	0.533***	0.381***	0.157***	0.210***	0.072***	0.162***	0.272***	0.095**
	(0.053)	(0.079)	(0.048)	(0.060)	(0.029)	(0.051)	(0.027)	(0.059)	(0.034)	(0.037)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean	3.635	4.007	3.418	3.835	4.369	4.360	4.572	4.075	4.072	4.633
n(Obs)	3,146	3,141	3,143	3,139	3,254	3,247	3,254	3,250	3,247	3,247
n(Faculty)	1,519	1,519	1,519	1,519	1,521	1,520	1,521	1,519	1,520	1,520

Note. ** $p < .05$, *** $p < 0.01$. In the table above, columns 1–10 display results from individual regression analyses. The "Mean dependent variable" signifies the average reported response within the analytic sample at baseline. The coefficient estimates, presented as the point change from the mean dependent variable, are accompanied by their corresponding standard errors (enclosed in parentheses) reported below.

Table 10

Changes in Faculty's Self-Efficacy and Mindset (Responded in All Periods)

		Subscales				Subscales				
	(1) Self-Efficacy	(2) Clarity	(3) Effective Teaching	(4) Adjustment	(5) Mindset	(6) Perceived Effective	(7) Personal Impact	(8) Growth Mindset	(9) Self-Improvement	(10) Enthusiasm
ACUE	-0.344***	-0.388***	-0.350***	-0.313***	-0.076**	-0.139**	-0.037	-0.069	-0.133	-0.057
	(0.065)	(0.069)	(0.083)	(0.069)	(0.037)	(0.057)	(0.041)	(0.080)	(0.069)	(0.081)
Midpoint	0.020	0.019	0.022	-0.001	0.018	-0.005	-0.024	0.080	-0.092	0.003
	(0.041)	(0.037)	(0.059)	(0.070)	(0.042)	(0.057)	(0.033)	(0.061)	(0.079)	(0.049)
Endpoint	0.040	-0.084	0.056***	0.012	0.011	-0.042	0.003	0.039	0.015	-0.095**
	(0.027)	(0.050)	(0.017)	(0.043)	(0.033)	(0.052)	(0.036)	(0.049)	(0.055)	(0.046)
Follow-up	-0.037	-0.143**	-0.026	-0.067	-0.013	-0.041	-0.014	0.016	0.010	-0.049
	(0.061)	(0.068)	(0.071)	(0.089)	(0.044)	(0.046)	(0.035)	(0.082)	(0.052)	(0.055)
ACUE*Mid	0.330***	0.167**	0.417***	0.240***	0.053	0.105**	0.028	-0.037	0.294***	0.063
	(0.062)	(0.066)	(0.083)	(0.076)	(0.033)	(0.044)	(0.030)	(0.078)	(0.063)	(0.055)
ACUE*End	0.531***	0.403***	0.661***	0.435***	0.122***	0.159***	0.062	0.028	0.334***	0.121**
	(0.046)	(0.069)	(0.047)	(0.040)	(0.033)	(0.047)	(0.044)	(0.096)	(0.062)	(0.056)
ACUE*Follow	0.529***	0.443***	0.631***	0.510***	0.179***	0.250***	0.075	0.118	0.364***	0.116
	(0.064)	(0.101)	(0.068)	(0.078)	(0.044)	(0.044)	(0.043)	(0.090)	(0.057)	(0.062)
Covariates	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Mean	3.593	3.989	3.365	3.814	4.372	4.362	4.576	4.051	4.063	4.631
n(Obs)	1,003	999	1,000	999	1,054	1,052	1,054	1,053	1,052	1,052
n(Faculty)	265	265	265	265	265	265	265	265	265	265

Note. ** p < .05, *** p < 0.01. In the table above, columns 1–10 display results from individual regression analyses. The "Mean dependent variable" signifies the average reported response within the analytic sample at baseline. The coefficient estimates, presented as the point change from the mean dependent variable, are accompanied by their corresponding standard errors (enclosed in parentheses) reported below.

Table 11

Usage of Different Courseware/Digital Tools by Faculty Type

	Faculty type							
	ACUE				Comparison			
	Baseline		Endpoint		Baseline		Endpoint	
Tools	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD
Video feedback	.23	.42	.12	.32	.15	.36	.22	.41
Surveys	.42	.49	.30	.46	.39	.49	.28	.45
Anonymous grading	.12	.32	.10	.30	.20	.40	.15	.36
Breakout rooms	.42	.50	.21	.41	.37	.48	.22	.41
Recording software	.51	.50	.22	.42	.48	.50	.36	.48
Audience response systems	.28	.45	.11	.31	.20	.40	.18	.39
Online collaboration tools	.52	.50	.27	.45	.46	.50	.45	.50
Digital courseware	.50	.50	.26	.44	.57	.50	.49	.50

Table 12

Usage of Different Digital Courseware Programs by Faculty Type

	Faculty type							
	ACUE				Comparison			
	Baseline		Endpoint		Baseline		Endpoint	
Programs	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD	Mean (%)	SD
Acrobatiq	.002	.05	.01	.09	0	0	0	0
Cerego	.002	.05	.002	.05	.007	.08	0	0
CogBooks	0	0	.002	.05	0	0	0	0
Lumen Learning	.03	.18	.03	.16	.12	.32	.05	.22
OpenStax	.12	.33	.06	.24	.15	.36	.14	.35
Smart Sparrow	.01	.11	.02	.13	.007	.08	.007	.08
Stanford Opening Learning Initiative (OLI)	.01	.10	.01	.11	.007	.08	.007	.08
Other	.54	.50	.26	.44	.36	.48	.38	.49

Table 13

Proportion of Students' Responses to the Question "How aware are you of your school's efforts to improve student success?"

	Student sample			
	Spring 2022		Fall 2022	
Response	Mean (%)	SD	Mean (%)	SD
I do not know if my school has any efforts to improve student success.	.06	.23	.06	.23
I think that my school has efforts to improve student success, but I don't know what they are.	.15	.36	.18	.38
I know what at least some of my institution's student success initiatives are, but I don't know the details of any of them.	.17	.38	.20	.40
I know the details of some, but not all of my institution's student success initiatives.	.36	.48	.30	.46
I have detailed knowledge of all of my institution's student success initiatives.	.18	.39	.21	.40
My institution does not have any student success initiatives.	.003	.05	.005	.07

Figures

Figure 1

Proposed Model of Faculty Mindset Changes Resulting from ACUE Courses

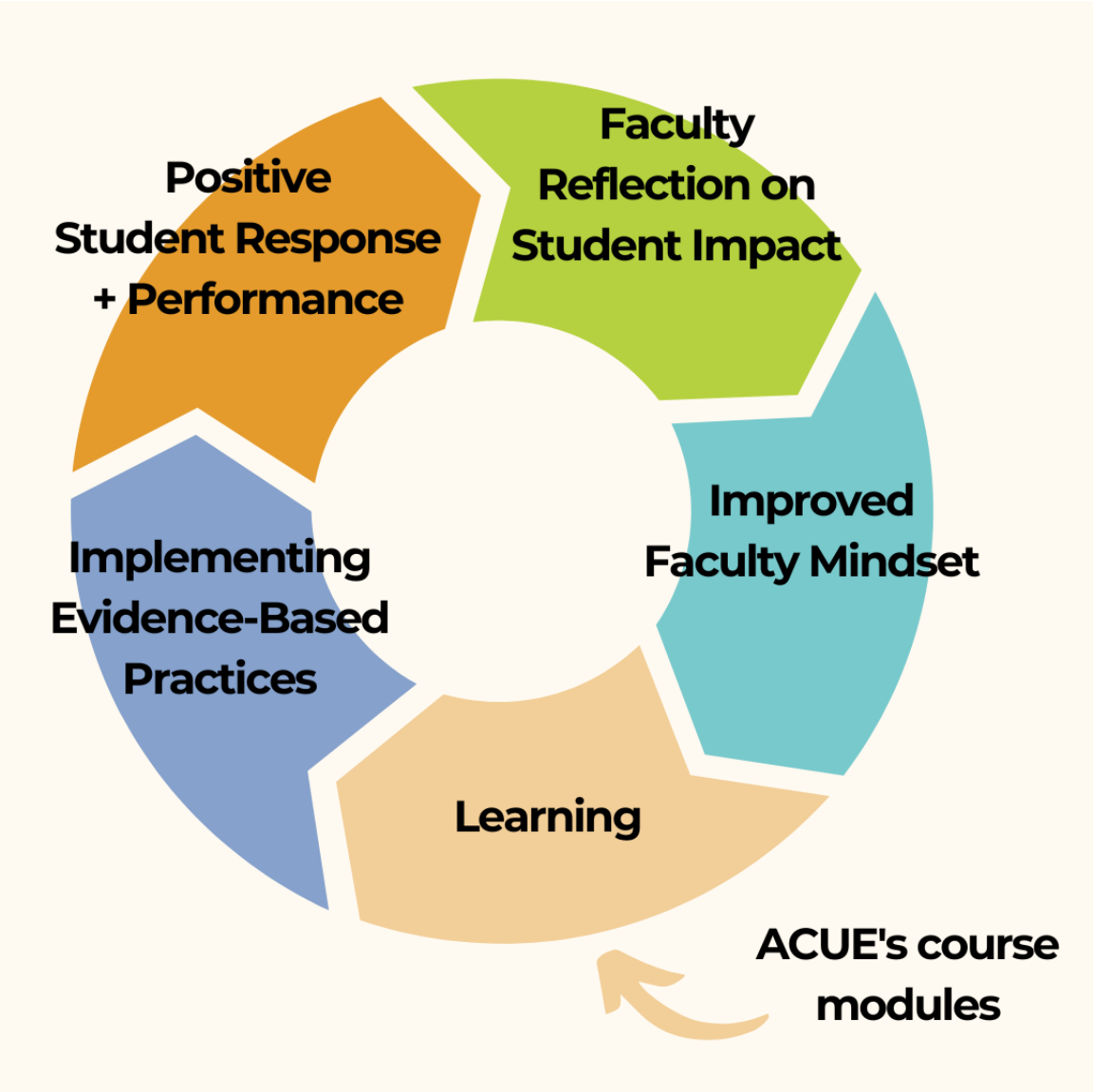
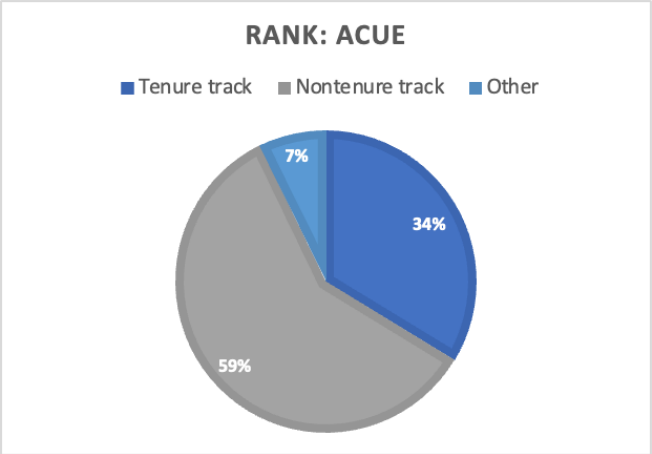


Figure 2

Faculty Rank by Group



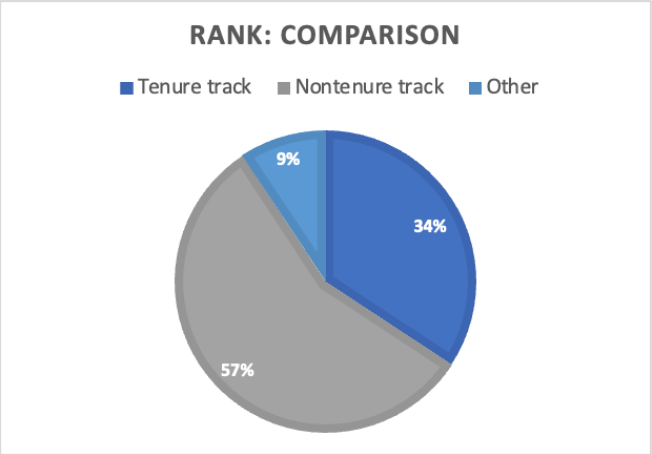
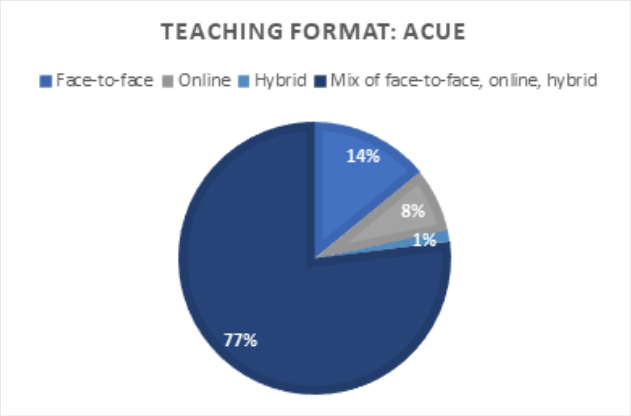


Figure 3

Faculty Teaching Format by Group



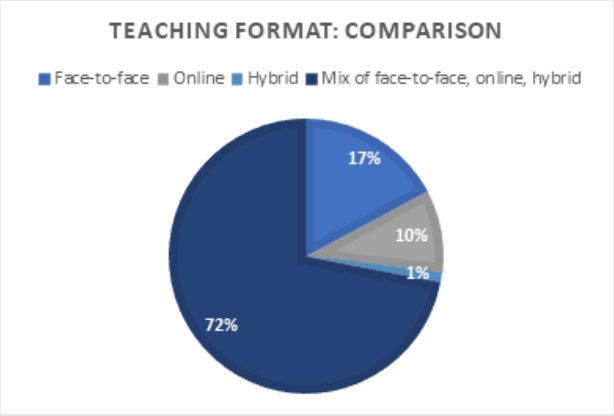


Figure 4

Faculty Gender by Group

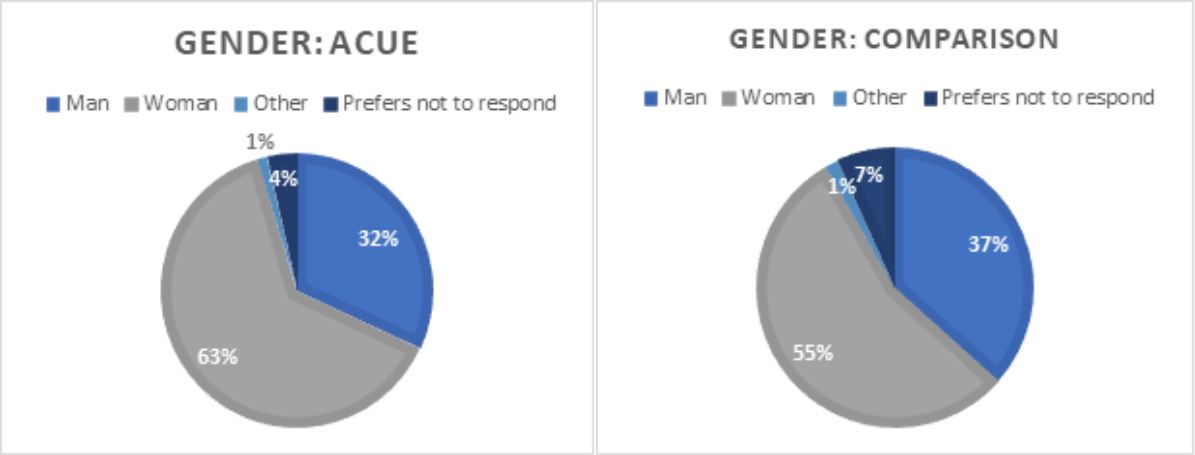


Figure 5

Faculty Race/Ethnicity by Group

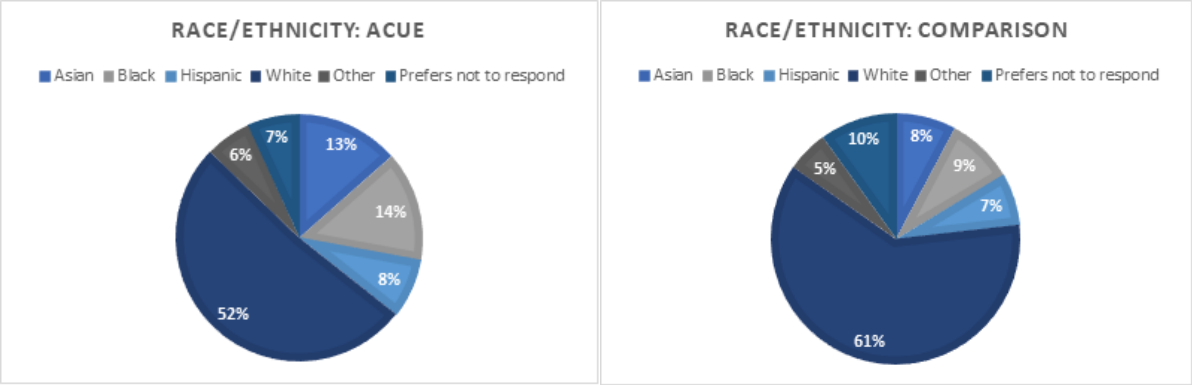
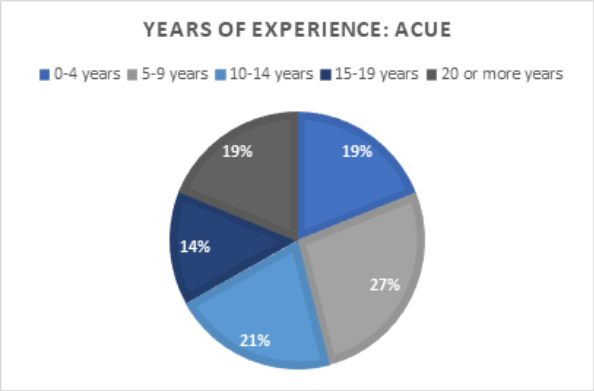


Figure 6

Faculty Years of Experience by Group



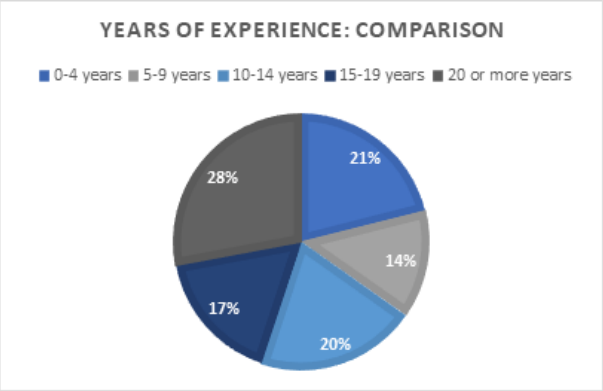
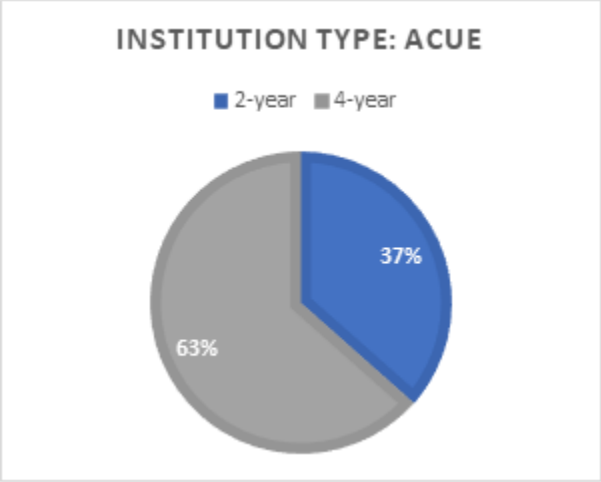


Figure 7

Institution Type by Group



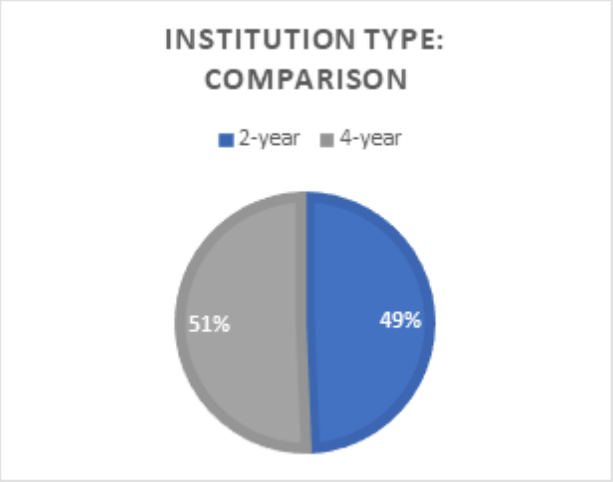
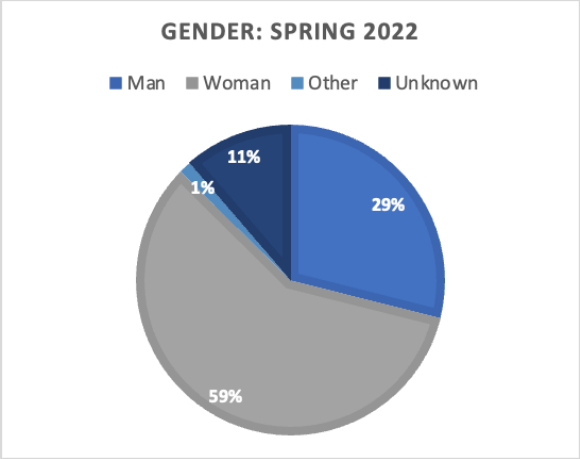


Figure 8

Student Respondents' Gender



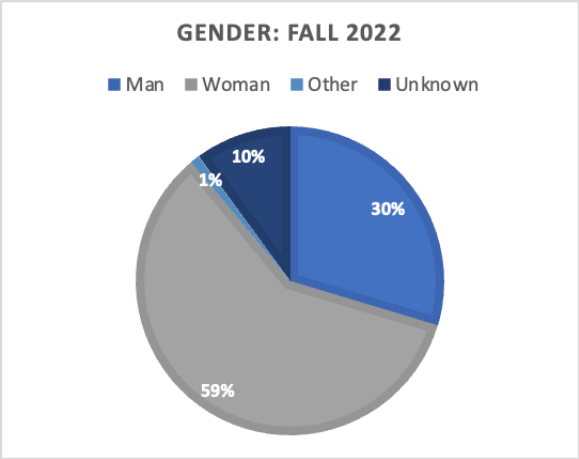


Figure 9

Student Respondents' Race/Ethnicity

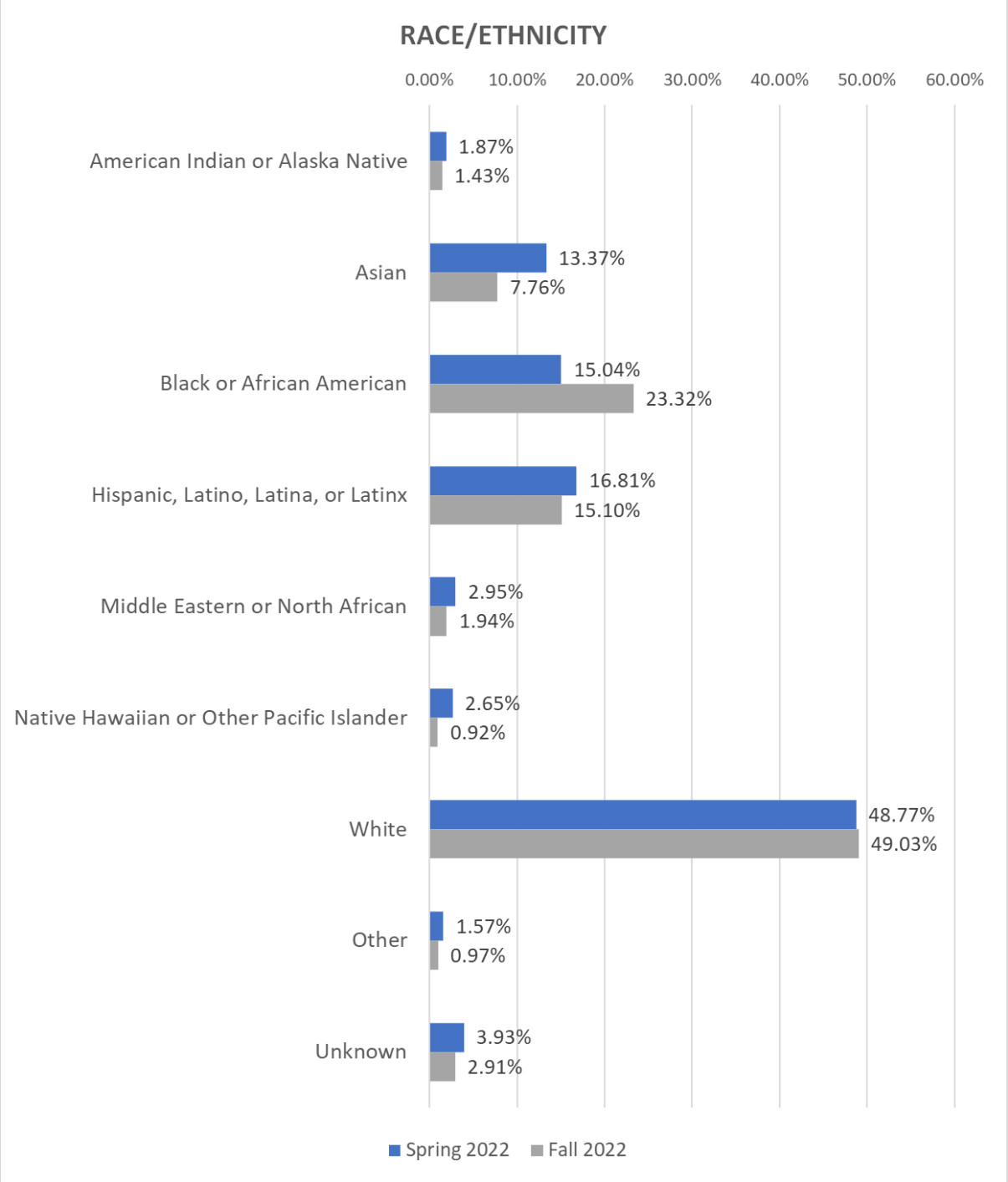
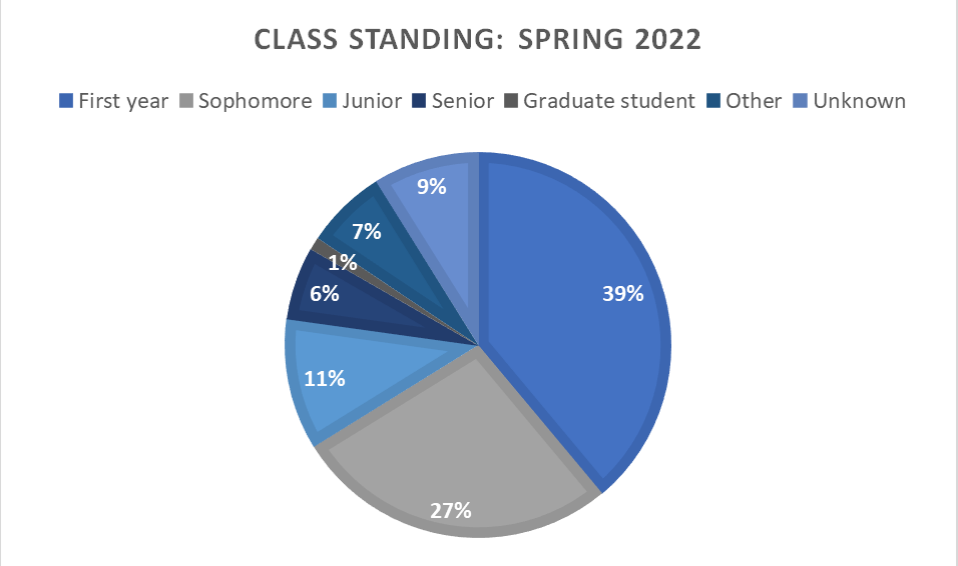


Figure 10

Student Respondents' Class Standing



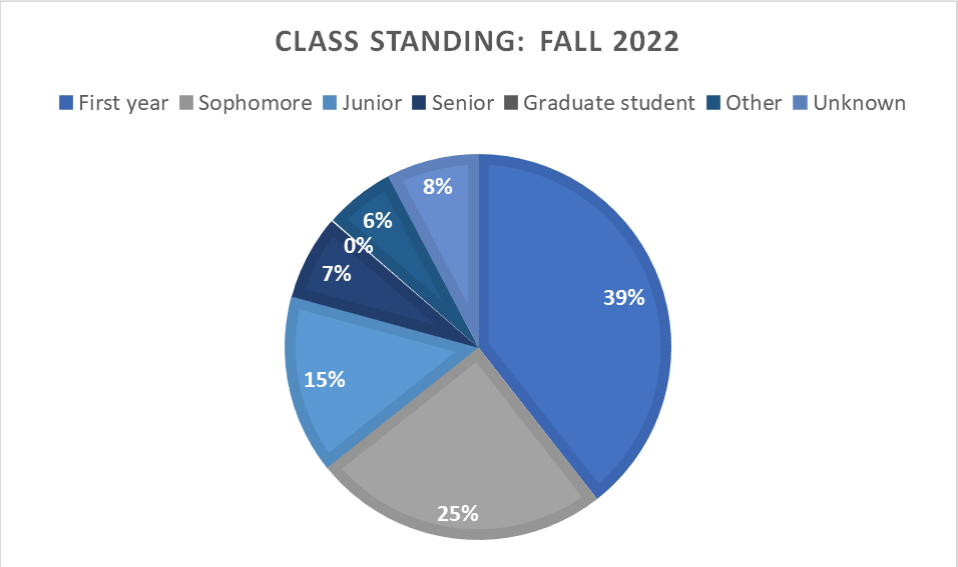


Figure 11

Student Respondents' Student Status

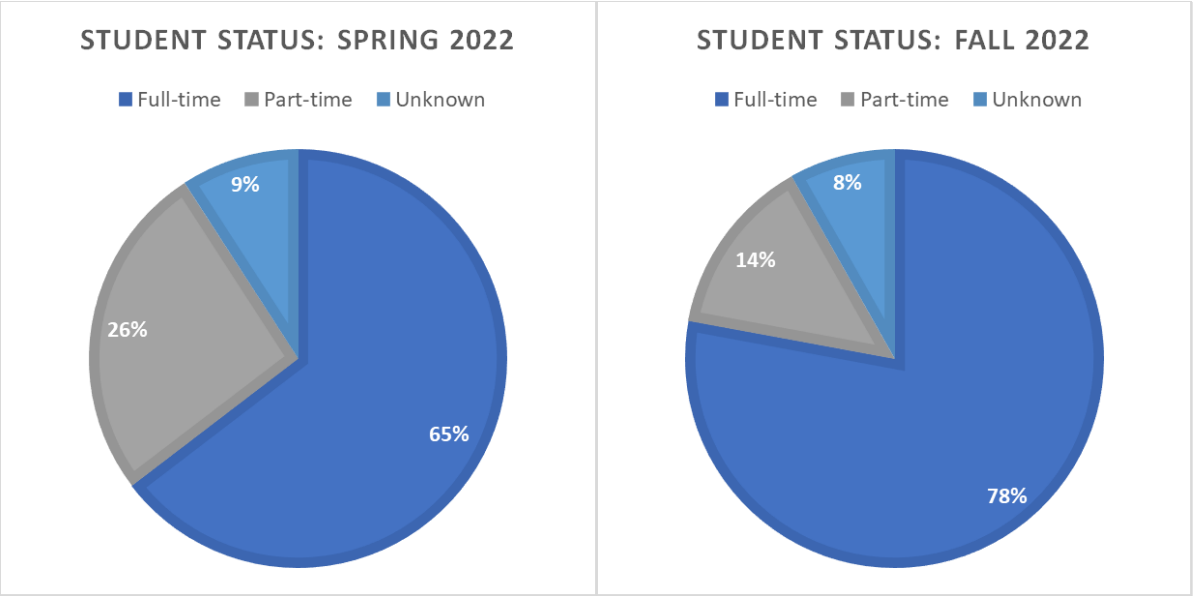
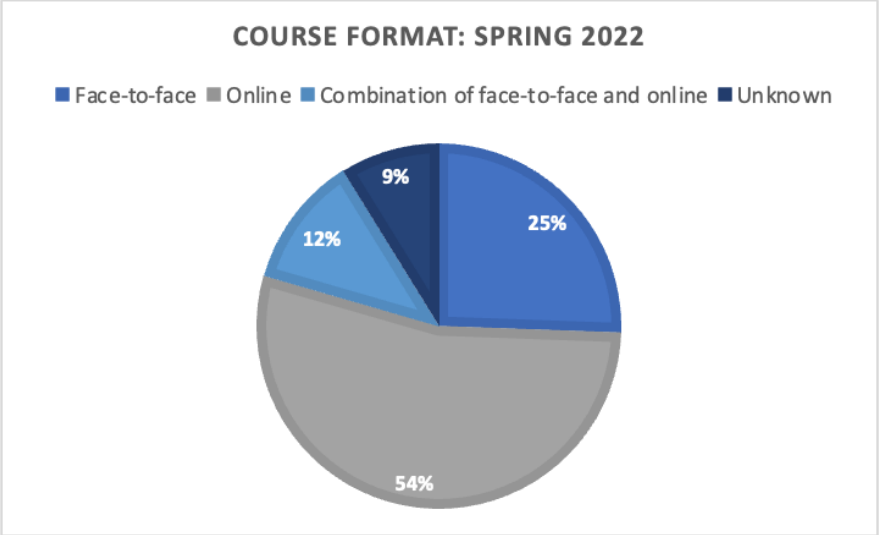


Figure 12

Course Format of Student Respondents



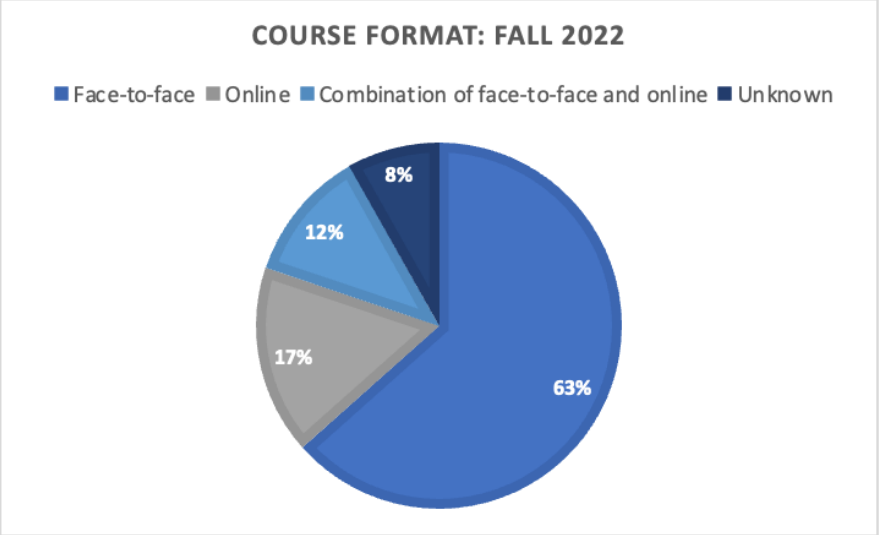


Figure 13

Institution Type of Student Respondents

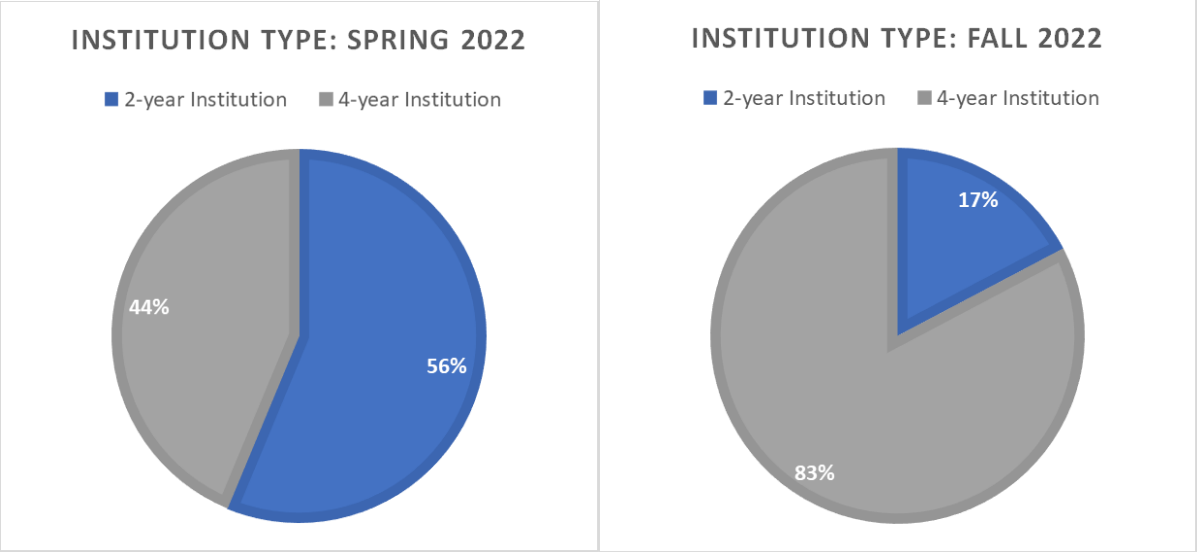


Figure 14

Faculty's Current Use of Digital Tools

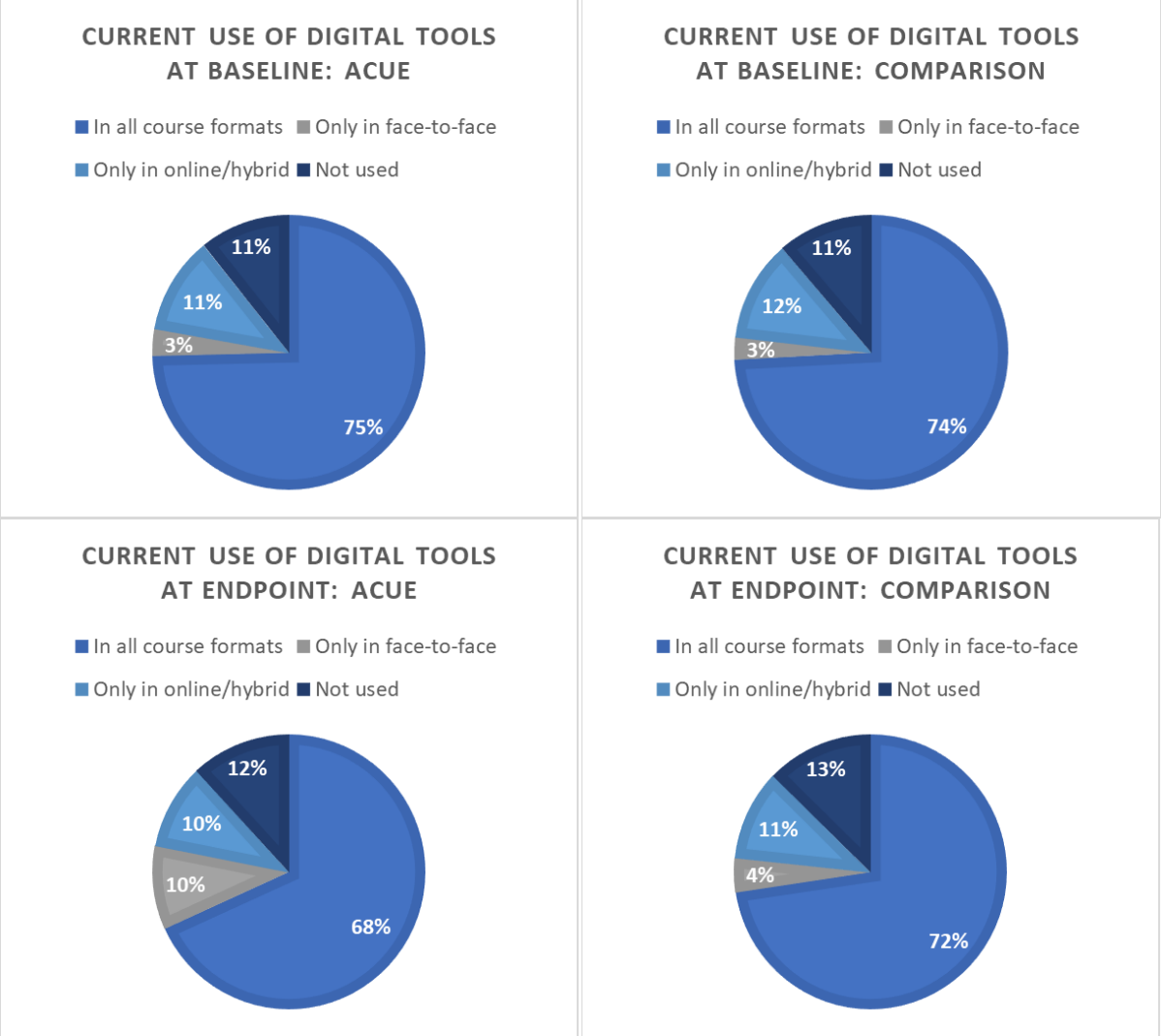


Figure 15

Perceived Increase in Students' Growth Mindset

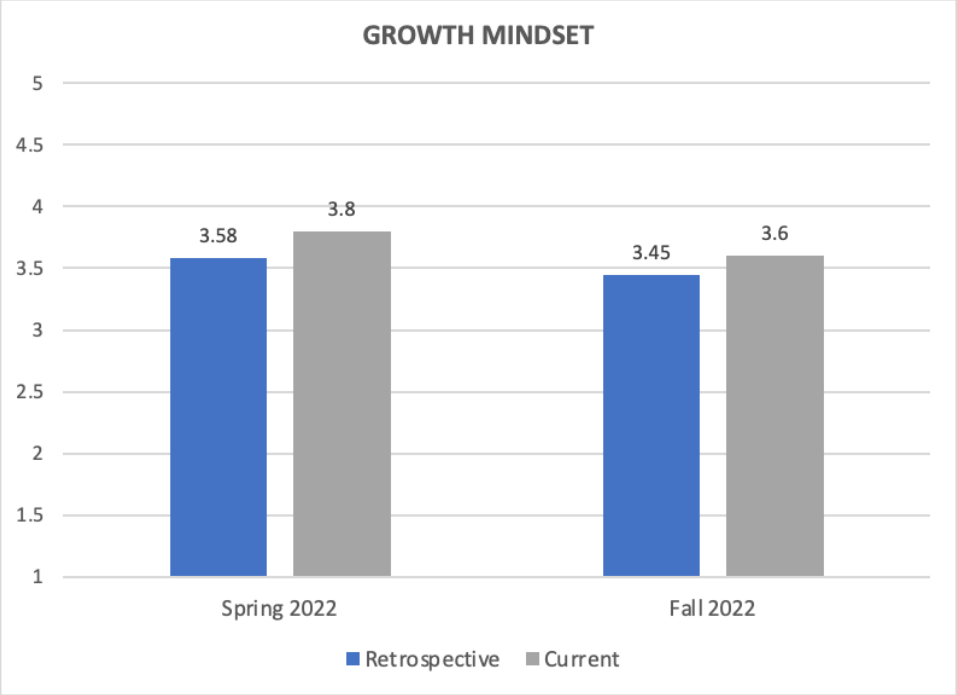


Figure 16

Perceived Increase in Students' Academic Self-Efficacy: Communication

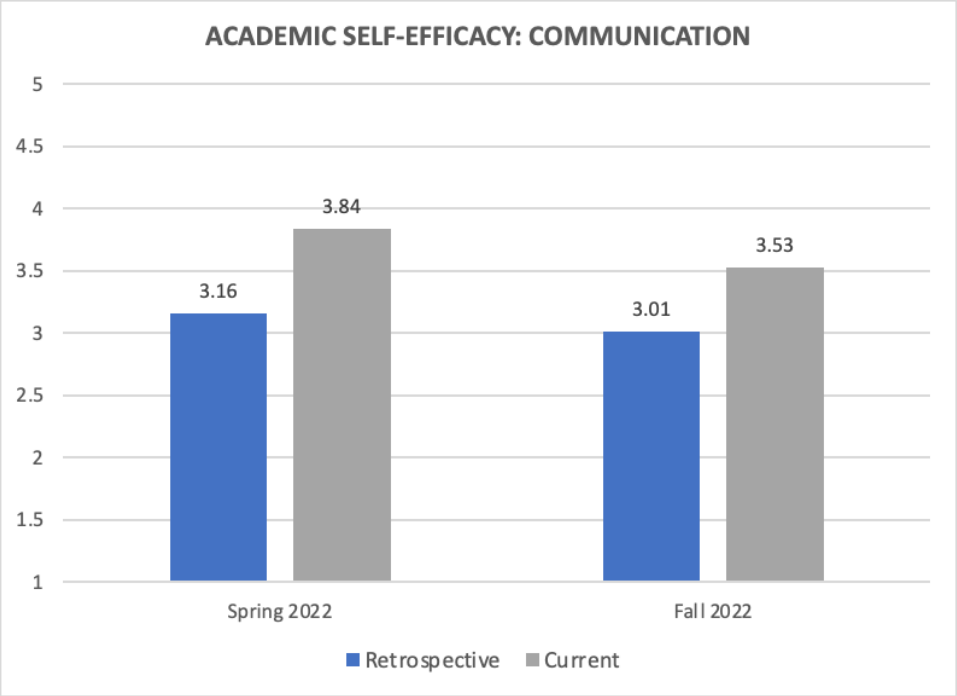


Figure 17

Perceived Increase in Students' Academic Self-Efficacy: Self-Monitoring

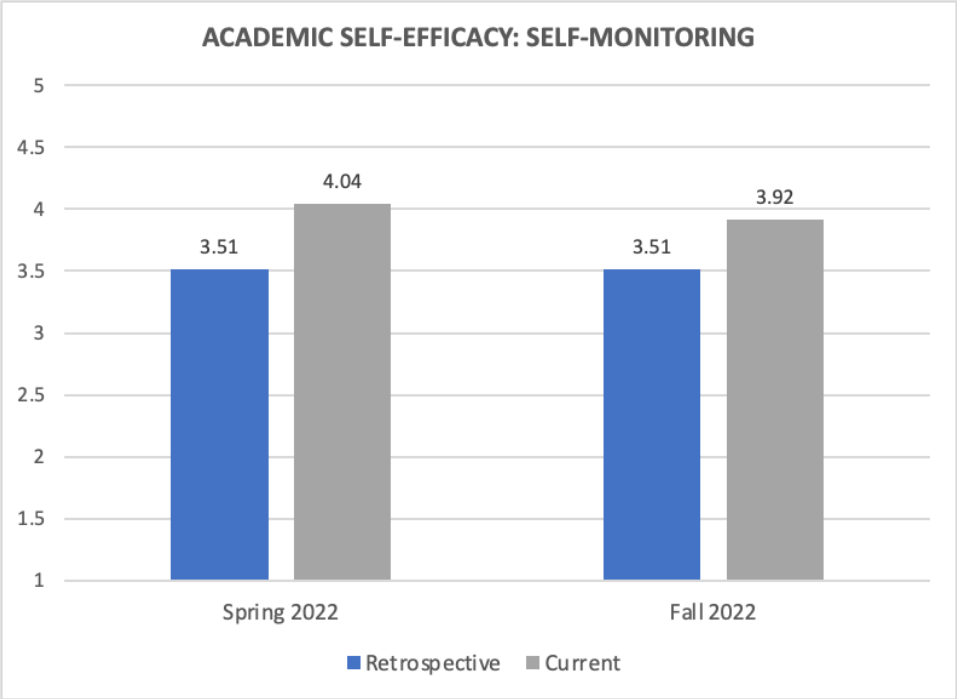
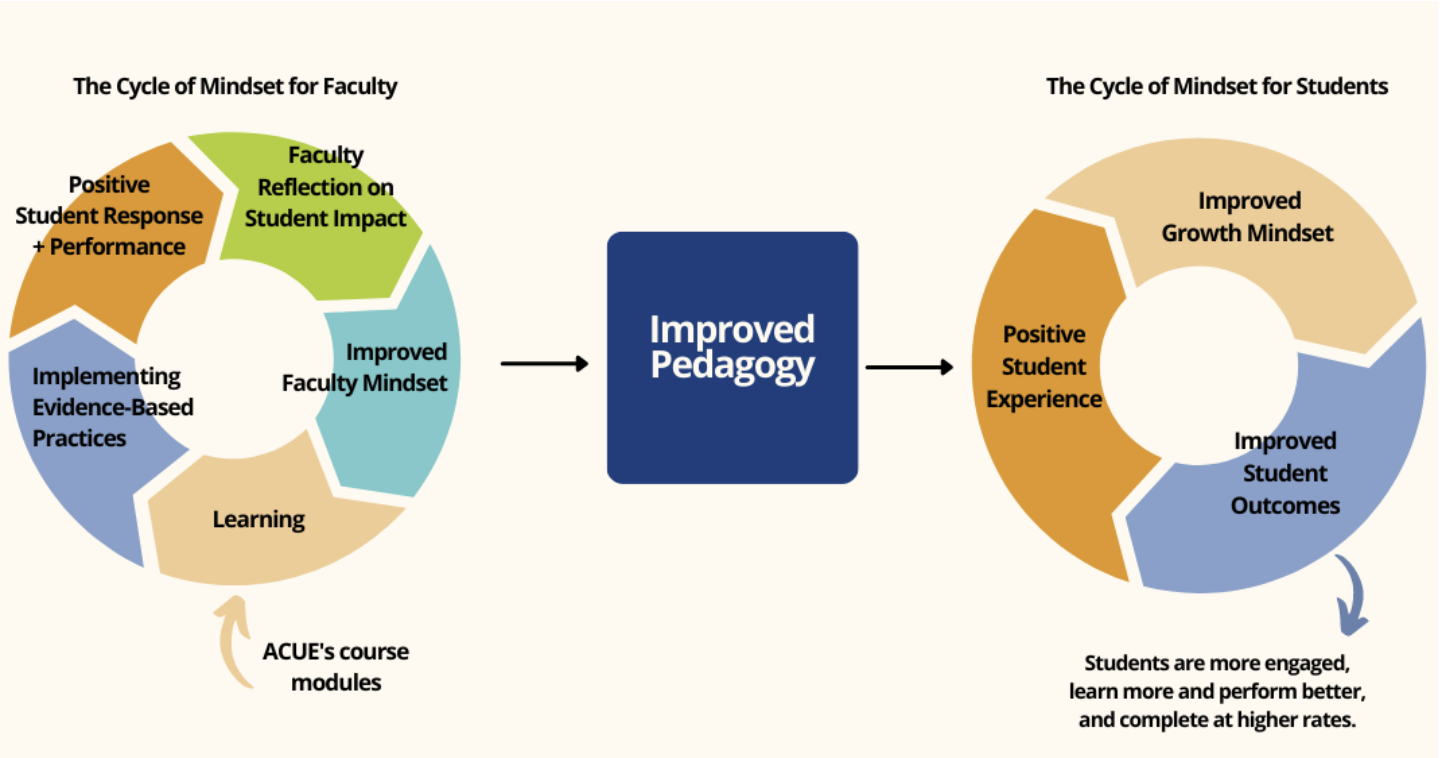


Figure 18

Proposed Model of Faculty and Student Mindset Changes Resulting From ACUE Courses