



## Effective Teaching by the Association of College and University Educators (ACUE) in Undergraduate Mathematics Class

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# Effective Teaching by the Association of College and University Educators' (ACUE) in Undergraduate Mathematics Class

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## Abstract

Teaching effectively in college is not only key for student' satisfaction in classroom but also for performance. This research, as a pilot study, has analyzed the survey and course evaluation results from an undergraduate Mathematics class, where The Association of College and University Educators' (ACUE) effective teaching practices are applied. Results have shown the positive effects from ACUE practices. At the same time, differences in student performance in the same courses from different semesters have been discussed. With the same course content and learning outcomes, teaching with ACUE practices has resulted in better performance throughout the semester. The research compared course evaluations from the same courses in different semesters when including and not including ACUE practices. Results show that students are more satisfied with the courses using ACUE practices. Researcher has made suggestion that ACUE practices should be recommended for use by faculty members in universities and colleges to improve student performance and course satisfaction.

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## Introduction

When it comes to preparation for the first day of class, there is a common misconception that there is not much to prepare once the syllabus and learning outcomes have been created. Reading the syllabus does not guarantee students will process the course requirements or your expectations (Nilson, 2010). Motivated students will read the syllabus, but to ensure all students review it, actively engage them in a syllabus activity during class. Nilson (2010) suggested to design an activity that requires students to analyze the syllabus, determine the important facts, and ask questions to gain clarity. One of the ACUE practices for effective teaching is to ensure equitable access to learning. It is well documented that students from low-income backgrounds have less access to rigorous coursework in high school (Walpole, 2007). Students may have graduated at the top of their class and yet still arrive well behind their peers academically. This can be an emotionally jarring realization for students, who may also lack the study habits required to be successful in a rigorous college-level course. Helping students learn how to succeed in your course, using techniques presented in this module, will ensure that capable students are not being excluded from success because of poor preparation (S. McGuire, personal communication, February 22, 2016). Several of the most effective practices do not require extensive time but are related to the structure of the course. Having clearly written expectations and establishing grading practices that allow students to recover from early challenges are two ways to provide your students with support that does not necessitate individualized

attention (S. McGuire, personal communication, February 22, 2016). Other strategies may take extra time but can be one-time activities, such as setting up a resource bank, reviewing incoming student data, or administering a Semester Performance Prognosis Inventory. Ultimately, because effective strategies for underprepared students are also effective for well-prepared students, the time spent will benefit all students (S. McGuire, personal communication, February 22, 2016). Persistence problems in online courses are often related to feelings of isolation (Hart, 2012), feeling lost (Boettcher & Conrad, 2016), or feeling discouraged (Conrad & Donaldson, 2011). Instructors can address these persistence challenges by designing course activities and assignments that build community through paired and group work, providing organizational reminders and support, and checking in with students if they are falling behind (Boettcher & Conrad, 2016, Nilson & Goodson, 2018). Role-playing games, a great class activity, can help students persist in their studies by setting up long-term goals.

Stereotype threat is a phenomenon in which a person's concern about confirming a negative stereotype leads them to perform below their potential (Steele & Aronson, 1995). Essentially, stereotypes create a fear so strong that it influences the behavior of those affected. Stereotype threat is particularly dangerous because people are at risk simply by being aware of it, which is to say that the fear of being judged based on an existing stereotype is enough to disrupt performance even if the person does not actually believe it (Spencer et al., 1999). So breaking stereotypes in class should be done at the beginning of the semester by staying aware and informed of existing negative stereotypes, especially toward underrepresented students' populations in Mathematics classes at TAMU. When it comes to improving students' performance, previous studies have shown that it is critical to take advantage of every minute in class, including the last couple minutes. The end of class is a good time to check in with students about their initial understandings or misunderstandings using ungraded techniques like the One-Minute Paper, which is a summary note by students of what has been discussed in class, or automated online quizzes. This allows students to clarify and deepen their understanding about the content prior to engaging in a high-stakes quiz. These techniques also communicate to students the formative nature of deeper learning, which takes time and practice before students can be expected to demonstrate learning on a graded assignment (Howard, 2015). Try using a One-Minute Paper at the end of class or a One-Minute Thread Discussion forum that asks students to respond to two or three questions such as (a) what did you learn, and (b) what was the most difficult or confusing part of today's class? Use the information from the second question to identify any concepts that the instructor will need to address with the whole group, small groups, or individuals before moving on. This technique can give both the instructor and students helpful information about where they are in their mastery of the content (Nilson, 2010). The instructor can ask these same questions on an online discussion board and can require students to post their One-Minute Papers before seeing other posts. Grades can reveal a level of performance based on a scale, but they are often poor tools for indicating how performance can be improved. As Friend (2013) has explained, "There is virtually no way for a letter to convey any real meaning related to assessment unless some other text accompanies it, in the form of elaboration, explanation, or correlation. In that case, the grade is not the critical element; it is instead the comment to which the grade points." Peer review in class provides a great way for students to learn from their own mistakes and as well as their peers in class. Another thing you should cover in class is how to take notes effectively. Untutored note-taking is passive. Students attempt to record what the lecturer is saying without thinking about the ideas. Nilson (2010) cites research that "the average student's notes include only 10 percent of the lecture . . . and 40 percent of its critical ideas (first-year students,

just 11 percent)” (p. 122). Few students receive any tutoring on note-taking beyond “write down the important ideas,” but unless the student is immersed in the content, they do not know what is important (Rotenberg, 2010). Nilson (2010) suggested to talk with students about the organization of your presentation or lecture, offer a skeletal outline, or use prompts to indicate when ideas or concepts are important.

The rest of the paper is organized as follows. The modules and practices applied in class are discussed in the Method section based on the literature discussed above. Results from the survey and course evaluations are displayed in the Results section. The Discussion section presents reasons for the results and more recent results from other researchers. The Conclusion section presents the conclusions and recommendations we have developed from this pilot study.

## **Method**

### **Data and Variables**

An undergraduate class MATH 1325 Business Math II was selected to apply effective teaching practices in Fall 2022. Twenty-eight students enrolled in this class. Toward the end of semester, 21 students participated the survey, and the sociodemographic characteristic of participants are listed in Table 1. The majority of students was female. As an undergraduate course, MATH 1325 normally enrolls first- and second-year students from the business school at TAMU. As a Hispanic-Serving Institution (TAMU, 2022), 86% of the students in the class were Hispanic, which is typical. The practices of effective teaching by ACUE are listed in Table 2. ACUE effective teaching practices include four sections: Creating an Inclusive and Supportive Learning Environment, Promoting Active Learning, Inspiring Inquiry and Preparing Lifelong Learners, and Designing Learner-Centered and Equitable Courses. The first section, Learning the First Day of Class, discusses seven different modules: LE1–LE7. Using LE1 Leading the First Day of Class, based on the principals in this module, the instructor, Dr. Wang, designed a syllabus and had a quiz in class with students to learn the information in syllabus. Through the quiz time in class, students learned the details of syllabus and developed a clear idea about the policies and expectations for this course. LE2 is skipped for discussion in this research. LE3 Ensuring Equitable Access to Learning involved inviting students to write a letter to their future self and allowing oral or video presentations to submit assignments if students preferred. LE4 Helping Students Persist in Their Studies introduced a role-playing game to help students persist in their major studies. During this module, the instructor turned the classroom into a financial institution, where people can get a mortgage or a savings account. Students learned how to calculate compounded interest and how to make plan to pay off their first house in the future. To address LE5 Embracing Diversity in Your Classroom, the instructor spent time in class removing stereotype threats. She asked students if they like Mathematics. As expected, most students said that they hate Mathematics because they had very bad experience in previous Mathematics course. After learned the practices from ACUE, the instructor invited students to forget the unpleasant experience and try their best in this course as this was the first Mathematics course they have. In LE6 Checking for Student Understanding, he demonstrated how to use the One-Minute Paper activity at the end of class to help students summarize what they have learned. In LE7 Providing Useful Feedback, Dr. Wang pointed out that feedback could also be from peers rather than from the instructor only. Therefore, he led a peer review activity in class, which gave students an opportunity to grade their classmates’ work and learn how to write

the solutions to questions in an organized way. This research will also discuss the effect of practices from the section AL2 Teaching Powerful Note-Taking Skills. This module talked about skeletal outlines, which gave students an outline of the class notes the class will cover. This outline was created to help students save time writing everything down in class and feel confident understanding about what was covered in class.

ACUE sent a survey invitation to students at the end of the semester about their course experience. A summary of the survey results is listed in Table 3, Figure 1, and Figure 2. As part of the analysis in this research, student satisfaction and performance from the MATH 1325 course in different semesters were collected. MATH 1325 Fall 2022 was taught without any ACUE practices, whereas MATH 1325 Spring 2023 was taught with all the practices listed in Table 2. A comparison of teaching evaluations and student grades is listed in Table 4 and 5. Table 6 is grade distributions after adjustment. Using the sign test, we demonstrate the impact of ACUE effective teaching practices on students' performance.

## Results

MATH 1325 Business MATH II is the second class in the sequence of Business MATH. This course in Fall 2022 semester, the majority of students (81%) comprises sophomores and juniors, as seen in Table 1. Students in class are between 19 and 24 years old with an average of 20.43 years. Located on the border of United States and Mexico, TAMU has a large Hispanic or Latino population; 86% of students in MATH 1325 Spring 2023 was Hispanic or Latino.

Table 1. Sociodemographic Characteristics of Participants

Baseline characteristic	n	%
Gender		
<i>Female</i>	13	62
<i>Male</i>	8	38
Class year		
<i>Freshmen</i>	2	10
<i>Sophomore</i>	9	43
<i>Junior</i>	8	37
<i>Senior</i>	2	10
Enrollment Status		
<i>Full time</i>	19	90
<i>Part time</i>	2	10
Race and Ethnicity *		
<i>White</i>	3	14
<i>American Indian or Alaska Native</i>	1	5
<i>Hispanic or Latino</i>	18	86

Note: N=21. Participants were on average 20.43 years old.

\* This question allows multiple answers, so percentage may not sum to 100%.

All the practices applied in class MATH 1325 Fall 2022 and the corresponding ACUE modules are listed in Table 2.

Table 2. ACUE Practice in Class

ACUE modules	Practice application in class
LE1 Leading the first day of class	Designed syllabus and had a quiz in class with students to learn the information in syllabus
LE3 Ensuring equitable access to learning	Asked students to write a letter to their future selves and allowed oral and video presentations to submit assignments submission
LE4 Helping students persist in their study	Implemented a role-playing game
LE5 Embracing diversity in your classroom	Removed stereotype threats in class
LE6 Checking for student understanding	Assigned One-Minute Paper at the end of class
LE7 Providing useful feedback	Implemented peer review in class
AL2 Teaching powerful note-taking skills	Provided skeletal outlines

At the end of semester, everyone still enrolled in class was invited to do a survey regarding designing an effective course and class, establishing a productive classroom environment, using active learning techniques, and assessing to inform instruction and promote learning. Students had four options to choose: strongly agree, agree, neutral, and disagree. A summary of the survey results is shown in Table 3. Most students agreed or strongly agreed with the positive impact of ACUE practices; 90% students strongly agreed that “my instructor motivated me to work hard and to believe I can succeed” and “my instructor provided opportunities for all students to participate in discussions.” The only statement to which they disagreed (5%) was “I can see connections between what I learned in this course and my future goals.” Figure 1 is the percentage of respondents who agreed or strongly agreed that their instructor regularly engages in ACUE teaching practices. Greater than 94% students agreed or strongly agreed with the positive impacts of ACUE practices.

Table 3. Summary of the Survey

	Strongly Agree	Agree	Neutral	Disagree
<b>Designing an Effective Course and Class</b>				
The syllabus included the essential information I needed for this course.	81%(17)	14%(3)	5%(1)	
I had a clear understanding of what I was supposed to learn in this course.	67%(14)	24%(5)	10%(2)	

	Strongly Agree	Agree	Neutral	Disagree
The class activities and course assignments helped me to be successful in this course.	76%(16)	24%(5)		
My instructor explained the reason for course activities and assignments	71%(15)	29%(6)		
<b>Establishing a Productive Classroom Environment</b>				
My instructor helped me feel welcome in and valuable to the class.	86%(18)	10%(2)	5%(1)	
My instructor motivated me to work hard and to believe I can succeed	90%(19)	10%(2)		
My instructor established course expectations for behavior that were clear and contributed to a positive learning environment	67%(14)	24%(5)	10%(2)	
The course environment was welcoming to diverse viewpoints	71%(15)	24%(5)	5%(1)	
My instructor helped me think about and prepare to meet my future goals	65%(13)	30%(6)	5%(1)	
I can see connections between what I learned in this course and my future goals.	52%(11)	33%(7)	10%(2)	5%(1)
<b>Using Active Learning Techniques</b>				
Course activities actively engaged students in learning course materials	86%(18)	10%(2)	5%(1)	
My instructor provided opportunities for all students to participate in discussions	90%(19)	10%(2)		
My instructor's lectures were clear and engaging	86%(18)	14%(3)		
My instructor provided opportunities for students to work in pairs or teams	86%(18)	5%(1)	10%(2)	
<b>Assessing to Inform Instruction and Promote Learning</b>				
Assignments expectations and grading criteria were clear to me	67%(14)	33%(7)		
My instructor's feedback helped me to improve my performance in this course	76%(16)	19%(4)	5%(1)	
My instructor made adjustments to instruction based on student learning needs and feedback	67%(14)	29%(6)	5%(1)	



Figure 1. Student Reports of Evidence-Based, Effective Teaching Practices in MATH 1325

(Note: % of respondents who agree or strongly agree that their instructor regularly engages in these teaching practices)

The student course evaluations in MATH 1325 from Spring 2022 and Fall 2022 were compared, and the results are displayed in Table 4. Comparing teaching without ACUE practices in Spring 2022 to teaching with ACUE practices in Fall 2022 showed increased student satisfaction in all five categories. The largest increase was in “ACUE made the class more well-organized” (4.06 to 4.75). This result also matches the academic self-efficacy report from the ACUE survey, shown in Figure 2. Among 21 students who participated the survey, 86% mentioned that they take good class notes in this course.

Table 4. Teaching Load Information and Course evaluations Comparison

Semester	Class	Format	1. Class engagement	2. Instructor feedback	3. Well-organized	4. Overall course quality	Combined
Spring 2022	MATH 1325	Face-to-face	4.4	4.59	4.06	4.53	4.41
Fall 2022	MATH 1325	Face-to-face	4.7	4.75	4.75	4.75	4.55

Note: The evaluations were in the range of 0-5.

Academic achievements in MATH 1325 Spring 2022 and Fall 2022 are compared and displayed in Table 5. Letter grades were calculated at the end of semester, which included homework assignments average (25%), two midterm tests (20% each), and comprehensive final (35%). Homework assignments were from Pearson MyLab Math online system and were assigned weekly. Each midterm test covered different chapters from the textbook, thus the weight of 20%, less in the overall grade compared with 35% for the final, which covered all the chapters in the textbook.



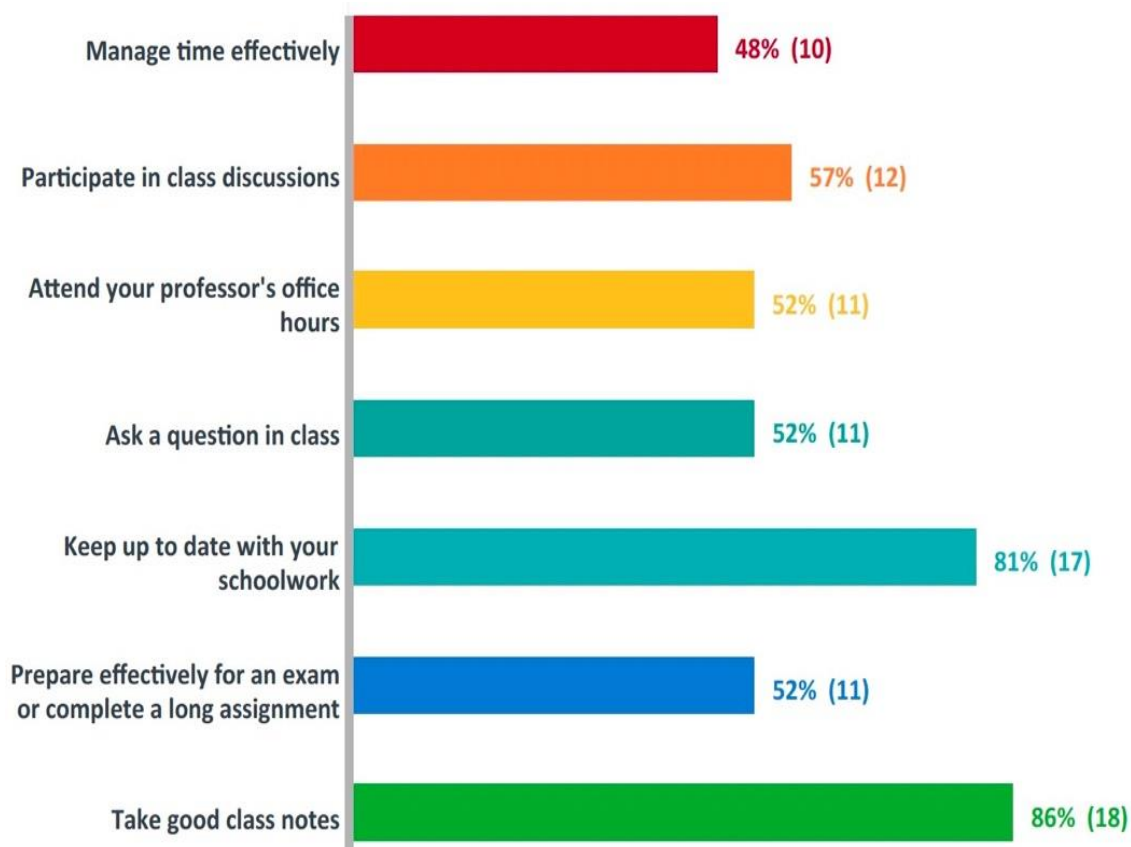


Figure 2. Academic Self-efficacy in MATH 1325

(Note: % of respondents reporting confidence)

Students with an overall grade between 89.5 to 100 received the letter grade A. With overall grades 79.5 to 89.4, 69.5 to 79.4, and 59.5 to 69.4, students received letter grades B, C, and D, respectively. If the overall grade was less than 59.4, students would receive a letter grade F. With a poor showing in comprehensive final, students would have little chance to pass the course due to its heavy weight. Therefore, failure due to missing the final has been listed separately.

Table 5. Grade Distributions

Semester	Enroll	A	B	C	D	FN*	F
Spring 2022	17	6	3	2	1	0	5
Fall 2022	28	5	7	2	2	3	9

Note: \* FN is for failure because of missing the comprehensive final.

Table 6. Grade Distributions after Adjustment

Semester	Enroll	A	B	C	D	FN*	F
Spring 2022	17	6	3	2	1	0	5
Fall 2022	18	5	7	2	2	0	2
Change of signs	+	-	+	+	+	+	-

Note: \* FN is for failure because of missing the comprehensive final.

## **Discussion**

This research is to summarize the impact of ACUE effective teaching practice in an undergraduate Mathematics course. In MATH 1325 Fall 2022, there were 28 students enrolled. As semester passed by, only 21 students attended class regularly. Among 21 students who participated the survey and course evaluation, only one student disagreed with the statement “I can see connections between what I learned in this course and my future goals.” At least 19 students strongly agreed or agreed to all the statements regarding the effective design of the course, establishing a productive environment, using active learning techniques, and assessing to inform instruction and promote learning. Compared with students from the class without ACUE practices in Spring 2022, students in Fall 2022 demonstrated higher course satisfaction in course quality and experience. In Table 4, under the statement about overall course quality, student evaluation increased from 4.53 out of 5 in Spring 2022 to 4.75 out of 5 in Fall 2022. Meanwhile, ACUE practices also improved students’ time management, communication with professors, keeping up to date with schoolwork, preparation for exams or assignments, and class note-taking, which can be found in Figure 2. The results indicate that ACUE practices have helped students in their academic life and increased the course satisfaction. These results agree with the previous studies (Morrison, Ross et al 2017, Morrison, Wilson et al 2017). The result from Mangum (2017) also summarized that through ACUE, faculty members are bridging the gap between the faculty and students and seeing dramatic payoff in both students’ success and faculty satisfaction.

When it comes to the student performance in course, comparing grade distribution from Spring 2022 to Fall 2022, which is displayed in Table 5, more students failed in Fall 2022 when ACUE practices were used in teaching than in Spring 2022 without ACUE practices. This might be related to the fact that seven students stopped attending class early in the semester of Fall 2022. These students did not drop or withdraw from class. Additionally, three students in Fall 2022 did not attend the comprehensive final, which resulting in failing grades. If those 10 students are taken from the enrollment, the grade distribution is significantly different, shown in Table 6. The sign test is a statistical method to test for consistent difference between pairs of observations before and after treatment. When it comes to paired responses, it is convenient to check whether that one condition is preferable to another by sign test (Dixon 1946). Previous study has discussed versions of the sign test in the presence of ties and had very promising results with regards to the application of the use of sign test (Coakley and Heise, 1996). It has been applied in clinical trial for experiment design (Nietert and Dooley, 2011). The sign test in this research has shown that the number of students who failed in MATH 1325 has dropped in Fall 2022 compared with the situation in Spring 2022. Only two students failed due to poor performance in Fall 2022. Sign test also shows that when ACUE practices are used in class, the number of students who received a letter grade of B and D was double in Fall 2022 when compared with the grades in Spring 2022. A recent meta-analysis (Business Wire 2022) conducted by Dr. Elizabeth Tipton from Northwestern University indicates that students from ACUE partners can expect on average 1 percentage point increase in course completion rates, 3 percentage point decrease in DFW rates, and .06 point increase in students’ average course grades. This study matches the results from Dr. Elizabeth Tipton’s analysis. Figure 3 and Figure 4 summarize the results from students’ questionnaire in all disciplines from all types of institutions in U.S. (ACUE, 2022). Nationwide, ACUE effective teaching practices have increased students’ satisfaction and performance.



Figure 3. Student Reports of Evidence-Based, Effective Teaching Practices

(Note: % of respondents who agree or strongly agree that their instructor regularly engages in these teaching practices)

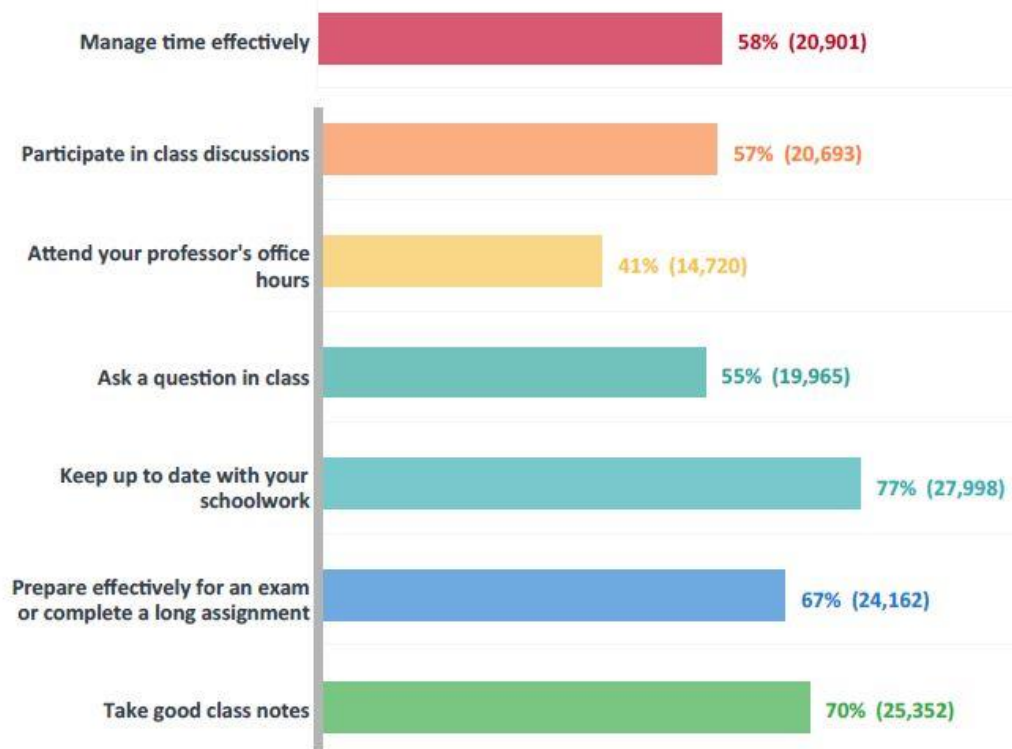


Figure 4. Academic Self-efficacy

(Note: % of respondents reporting confidence)

## Conclusion

Based on the results from the same course in different semesters (Spring 2022 and Fall 2022), which ACUE was applied in only one semester (Fall 2022), results show that ACUE practices have improved teaching effectiveness as well as student course satisfaction and performance. The once-a-week online module turned out to be convenient and flexible for professors who teach and engage in research and other department service. Higher educators would be highly recommended to take this course for self-improvement purposes. The study by Mangum (2017) summarized that ACUE offers an essential service to higher education and prepares faculty members with their “degree” in pedagogy, which can be nation’s teaching center and help faculty members change lives. Therefore, recommendation from this study would be made that ACUE effective teaching practices should be introduced to as many faculty members as possible, which includes tenure-track faculty members and non-tenure-track faculty members. Workshop or seminars can be held from time to time on campus for scholars from ACUE to discuss the progress they have made in the modules and share their experience in applying ACUE practices into their teaching. With regards to research purpose, data can be collected from all ACUE scholars’ classes to analyze the impact of ACUE effective teaching practices on students’ performance and satisfaction.

This research is limited by the sample size selected. Due to the small number of sample size, the results might not be accurate. It is also suggested that ACUE effective teaching practices should be recommended in other majors instead of only Mathematics. For future research in how ACUE effective teaching practices work, more data with larger sample size needs to be collected from both graduate and undergraduate classes. With more engagement within faculty members at TAMU, ACUE effective teaching practices will be applied in more classes from different majors such as other majors from STEM (Science, Technology, Engineering and Mathematics) as well as Humanities, Arts, Literature and Management.

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