Development and Implementation of an Undergraduate STEM Peer Coaching Program

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Undergraduate science, technology, engineering, and mathematics (STEM) experiences have academic, psychological, and social challenges that require additional support to navigate. This article explains the implementation of a STEM peer coaching program designed to provide such support. Through this program, undergraduate STEM students served as STEM peer coaches. Coaches facilitated one-on-one conversations focused on individualized support and skill development. Using carefully constructed planning and reflecting conversations, STEM peer coaches helped students clarify their goals and create plans for success. STEM peer coaches also served as accountability partners. Anecdotal evidence from students who participated in the program shows that STEM peer coaches provided meaningful academic support. The STEM peer coaching program is a model for how peer-led, individualized conversations can be a catalyst for helping students through challenges related to STEM. The article discusses key strategies for developing and implementing a STEM peer coaching program.

Undergraduate science, technology, engineering, and mathematics (STEM) experiences have academic, psychological, and social challenges that contribute to high attrition rates (Seymour & Hewitt, 1997; Seymour & Hunter, 2019; Xu, 2018). In terms of academics, students’ grades are significant predictors of persistence in their STEM major (Hunter, 2019; Premraj et al., 2021). Undergraduate students are often expected to apply STEM concepts more rigorously than they did in high school. This change demands metacognitive skills to evaluate and modify study habits to address higher academic expectations effectively.

Students may also face new psychological challenges related to their academic performance. For example, they could earn a lower-than-anticipated score on an exam and need help recovering emotionally from this type of setback. Students who experience these challenges would benefit from knowing such challenges are common in STEM learning and that successful students embrace these encounters through a growth mindset (Limeri et al., 2020). Students may also experience new social norms in STEM courses that act as another barrier to success. Ost (2010) found when students interact with successful peers who persist in their major, they are more likely to continue themselves. Students should therefore be intentional about developing relationships that will support their academic goals. Learning how to apply metacognition strategies and employing a growth mindset shared by experienced STEM students in a coaching role could facilitate effective navigation through the many challenges that STEM students experience.

At the University of West Florida, the development and implementation of a STEM peer coaching program aimed to facilitate the cultivation of metacognitive skills and the enactment of a growth mindset among first-year and transfer students taking introductory STEM courses to help them navigate STEM-related challenges (e.g., improving study strategies, navigating setbacks, serving as accountability partners). Developing metacognitive skills and enacting a growth mindset allow STEM students to systematically employ strategies that can help them achieve their goals in STEM and embrace adversity (Dweck, 1986; Limeri et al., 2020; McGuire & McGuire, 2018). Flavell (1976) defined metacognition as being consciously aware of yourself as a problem-solver in your ability to monitor, plan, and manage your mental processing and accurately judge your learning level. When they have a large amount of material to cover and a faster pace of science coursework in college, students need metacognitive skills to study effectively. By taking a direct approach, students focus inwardly to identify strategies that work for them. Furthermore, these skills can motivate students to apply a growth mindset to their science coursework by showing how they can improve (Dweck, 1986). Students with these skills have a path
for shifting their mindset from “I am not a science person” to “I need to find another way to study for exams.”

The STEM peer coaching program

A U.S. Department of Education Title III grant provided funding for implementing a STEM success program focused on facilitating active-learning strategies at a predominately White, regional comprehensive public university located in the Southeast with approximately 13,000 students (including approximately 3,000 STEM majors). Upon internal assessment, several factors were identified as shaping the development and implementation of the program. In a survey of STEM students,

• 71% said they commute to campus,
• 81% said they maintain jobs in addition to their studies,
• 34% said they work more than 20 hours per week, and
• 96% said they have full-time credit loads.

The STEM success program was a response to these statistics and involved a three-prong approach, with each prong intended to increase persistence by first-year and transfer students, with a particular emphasis on students enrolled in early STEM courses. These three initiatives included increasing active learning in the classroom; providing small-group, peer-led problem-solving sessions; and giving students the opportunity to participate in one-on-one conversations with STEM peer coaches to develop their metacognitive skills and employ a growth mindset. This article focuses on the third initiative by describing the development and implementation of a STEM peer coaching program at the University of West Florida. The pilot year for the STEM peer coaching program began during the fall 2019 and spring 2020 semesters. During the fall 2019 semester, coaching was conducted in person on campus with one-on-one meetings. The spring 2020 semester required adjustments due to the COVID-19 pandemic, including a quick adaptation to meet student needs, such as rapid transitions to online instruction and an increased emphasis on time-management skills. Midway through the spring 2020 semester, coaching sessions were held virtually using Google Meet and Zoom. All coaching appointments were held virtually during the fall 2020 and spring 2021 semesters. As students returned to in-person classes and services in fall 2021, they had the option to choose between in-person and virtual coaching sessions.

STEM peer coaching program at the University of West Florida

The STEM peer coaching program aimed to help students develop metacognitive skills and enact a growth mindset. Combining essential elements from Bettinger and Baker (2014) and Robinson (2015), the primary roles of STEM peer coaches are outlined in Figure 1. STEM peer coaches guided students in connecting daily activities to their long-term goals. They supported the development of time-management skills, study skills, metacognitive strategies, and self-advocacy by sharing their own experiences and university resources. They helped students navigate their thinking in becoming self-directed learners. In doing so, STEM peer coaches nurtured the skills and resources students already possessed to help them see how they could achieve success. STEM peer coaches used questioning techniques combined with paraphrasing to listen and navigate conversations. They led the planning and reflecting conversations through a tiered questioning technique to help the students being coached mediate their own thinking (details provided in “Planning Conversations”).

STEM peer coaches were experienced undergraduate students who had recently completed the targeted courses. They served as the “more knowledgeable other” who could relate and guide students in the subsequent development step (Vygotsky, 1978). STEM peer coaches shared their growth mindset journey with students as they guided them in improving performance and prioritizing their academic studies. Coaches were compensated for their time and worked approximately 2 to 4 hours per week depending on their availability and stu-

FIGURE 1

Roles of a STEM peer coach.
1. Provide individualized support.
2. Facilitate skills development (e.g., time-management skills, study skills, metacognitive skills, self-advocacy).
3. Seek to elicit solutions and strategies from students.
4. Nurture skills and resources students already possess.
5. Empower students through the development of a growth mindset.
6. Navigate student thinking with open-ended inquiry to reflect, plan, and set goals.
7. Assess the student’s life outside school (e.g., financial obligations, commitments).
8. Integrate into the university community.
9. Provide referrals to campus resources and offices.
10. Serve as an accountability partner.
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In addition to extensive training (detailed in “Training”), their weekly work hours included preparation time so they could review the intake forms and post-coaching time to record a summary of what occurred during coaching sessions.

**STEM peer coaching within the university support system**

Given the many services offered to students (e.g., tutors, advisers, and counselors), this section specifies how STEM peer coaching fits within the University of West Florida support system. Coaches work toward objectives and goals through skill development, tutors address content, advisers plan course structure, and counselors focus on emotional issues (Robinson, 2015). Thus, STEM peer coaching complements other services within the University of West Florida student support system. To facilitate this role in the support system, a faculty member serving as the STEM coaching specialist worked to create and implement the coaching program. Taking common interests and backgrounds into consideration, the coaching specialist designed a process to match peer coaches with students seeking these services. The coaching intake form (Figure 2) provided necessary background information (e.g., year of study, whether the student was a transfer student or member of the military, number of hours worked) and indicated areas of need such as time management and development of study skills. The STEM coaching specialist took steps to ensure appointment scheduling was manageable for both the student and the coach.

**Recruitment and interview process**

The recruitment process for peer coaches included faculty recommendations, invitational emails, informational posters, and postings to the university’s internal job website. Application questions were intentionally developed to reveal qualities such as students’ ability to overcome scholastic and personal challenges, use of a growth mindset, and proficiency in STEM course content. The interview process solidified whether students had these qualities. Here are examples of the questions and prompts during the interview process:

- What do you wish someone would have shared with you about being successful with your first STEM course?
- Describe a class you may not have been successful in when it began and what you did to improve your performance.
- Describe some of the skills you need to be successful in STEM coursework (e.g., goal setting, time management).

Applicant answers included nuances of what makes a successful STEM student. These responses clarified how applicants bridged educational gaps from their own high school and community college (where applicable) experiences to the increased rigor and demands of university-level STEM courses. Applicants shared that they wished they had known the importance of completing ungraded homework, going to the professor’s office hours, and using other university support services. A typical sentiment shared was that applicants wanted to encourage all STEM students to persist and learn from the unique challenges encountered by STEM majors. In summary, peer coaches who experienced their own struggles with STEM courses had the ability to share their wisdom, insights,
and empathy with peers. Additionally, showing STEM content proficiency helped other STEM students understand the relevance of the advice the coaches provided.

**Training**

STEM peer coaches had approximately 10 hours of training periodically throughout the academic year, including a daylong training before the fall 2019 semester. The initial training included the development of pausing, paraphrasing, and listening skills. Training included how to ask open-ended questions in a progression that would help students deepen their thinking and become more aware of their academic needs. Periodic training throughout the academic year aimed to help students employ a growth mindset and use metacognitive skills. Peer coaches received resources such as *Teach Yourself How to Learn: Strategies You Can Use to Ace Any Course at Any Level* (McGuire & McGuire, 2018) to help them deepen their understanding and have additional strategies to use in their coaching sessions. This ongoing training helped reinforce coaching skills and developed a sense of community among the coaches. In addition, the periodic training sessions offered an opportunity for coaches to share personal challenges related to coaching and strategies to overcome these challenges.

**The coaching experience**

**Planning conversations**

The Planning Conversation Map (Figure 3) was adapted to guide coaches in helping students clarify their thinking, set goals, and create an effective study plan (Bettinger & Baker, 2014; Costa & Garmston, 2002; McGuire & McGuire, 2018; Robinson, 2015). This tool helped students navigate STEM coursework and focused their efforts on developing effective study skills, metacognitive strategies, and time-management skills (Costa & Garmston, 2002). The questions were structured so that coaches could choose an item to focus on from each step. Beginning with clarifying goals, the map...
progresses to specifying success indicators, anticipating approaches, establishing personal learning focus, and reflecting on the coaching process. For example, a conversation with one student revealed that the student worked more than 20 hours per week off campus while taking a full course load, so the student needed study strategies to succeed on exams. Through inquiry, the coach determined the student was looking for test-taking skills and procrastination avoidance. As a result, the coach empowered the student to say no to outside distractors and developed a time-management calendar to help the student meet all deadlines. The coach paraphrased responses and asked questions to help the student navigate thoughts while planning for success. Paraphrasing was an essential skill used by coaches throughout their planning conversations. Coaches listened intently and stated the content and emotion of what students said before posing additional questions.

**Reflecting conversations**

Like the planning conversation, a Reflecting Conversation Map (Figure 4) shows an adapted inquiry pattern to help students clarify what happened, determine causal factors, and construct new learning (Bettinger & Baker, 2014; Costa & Garmston, 2002; McGuire & McGuire, 2018; Robinson, 2015). When students became cognitively aware of solving a problem, they entered a resourceful state in which they had access to various strategies. To facilitate this awareness, coaches used the pattern of pausing, paraphrasing, and inquiring at each step of the conversation. Question stems such as the following were used to prompt conversation:

- What comparisons might you make between how you planned for ____ and how it actually went?
- What are your hunches about what caused ______? What comparisons might you make between how you planned for ____ and how it actually went?
- What do you want to continue doing, and how might you refine what you are doing to make it even better?
- What learning(s) do you want to take with you into future situations?

Throughout this process, coaches used supportive communication techniques such as an approachable voice, plural forms, exploratory language (words like “hunches” and “might”), and positive presuppositions. The coach’s reflection questions aimed...
to help students employ a growth mindset and apply metacognitive strategies.

**Feedback loop through ongoing reflections**

The feedback loop shown in Figure 5 was used to improve the implementation of the STEM peer coaching program. Throughout the first year of the pilot program, individual meetings were held with coaches and the STEM success leadership team on a weekly basis. Additional meetings with all coaches were held every 3 weeks. The intent of these meetings was to better understand successes and challenges, build community, and further develop coaching skills. During these meetings, coaches discussed the following questions:
- What is going well?
- What are your challenges?
- Do you need anything?

These conversations and reflections shaped the STEM peer coaching program. For example, after the training session on navigating the Reflecting Conversation Map, coaches requested more discussions of different effective note-taking strategies to use during lectures. Note-taking techniques were shared in the following session, and coaches received *Teach Yourself How to Learn* (McGuire & McGuire, 2018) to help them learn effective strategies for studying and learning. The training was purposeful in building coaches’ skills and craftsmanship by listening and responding to their needs.

**Conclusion**

Throughout the implementation of the STEM peer coaching program, input from coaches, students, and faculty was used to meet the needs of the students receiving coaching. Future program implementation should include the addition of a satisfaction survey after each coaching session. Since fall 2019, 138 students have participated in coaching. In fall 2021, these students received a satisfaction survey via university email to complete; nine were undeliverable. Of the eight students who completed the entire survey, 100% expressed satisfaction with the STEM peer coaching service they received at the University of West Florida. Some students may not have responded because the survey was disseminated 1 or more semesters after they had engaged in coaching. Future study of this program could include further exploration of student satisfaction with STEM peer coaching programs and salient areas of development (e.g., time management, study skills, growth mindset) using real-time survey data.

The following five strategies are offered for consideration to develop and implement a successful STEM peer coaching program:
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1. Hire resourceful, relatable, and experienced coaches.
2. Provide coaches with opportunities to practice their skills throughout the semester.
3. Facilitate frequent, ongoing training.
4. Use the growth mindset and metacognitive strategies.
5. Base program development on coach feedback.

Ideally, STEM peer coaching applicants should demonstrate qualities of an effective coach during the interview process. Applicants who navigated challenges could relate to their peers and guide them in similar circumstances. Relatable coaches serve as “more knowledgeable others” to their peers. STEM peer coaches should use research-based questioning techniques to address students’ common academic, psychological, and social challenges in introductory STEM courses. Applicants’ ability to apply the growth mindset to their own experiences was a top priority during the hiring process, as this ability would encourage students to learn through their struggles. Training coaches throughout the semester provides opportunities to build their confidence and refine coaching skills. During training sessions, coaches shared feedback on how the program could improve based on their sessions with students. This feedback allowed for real-time modifications of the STEM coaching program and faster responses to coaches’ needs.

References

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