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Catherine A. Cherrstrom
Texas State University

Ra'sheedah Richardson
Texas A&M University

Debra Fowler
Texas A&M University

Robin Autenrieth
Texas A&M University

Mark J. Zoran
Texas A&M University

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Catherine A. Cherrstrom
Texas State University

Ra'sheedah Richardson, Debra Fowler, Robin Autenrieth, and Mark J. Zoran
Texas A&M University

ABSTRACT

Graduate school is an important time for future faculty to develop teaching skills, but teaching opportunities are limited. Discipline-related course work and research do not provide the pedagogy, strategies, and skills to effectively teach and compete for higher education jobs. As future faculty, graduate students will influence the future of science, technology, engineering, and mathematics (STEM) education through their teaching. The purpose of this case study was to examine future faculty's (graduate students') perceived teaching development during a semester-long STEM teaching development course. Findings included STEM future faculty's teaching confidence and skill development in instructional design, preparation, and facilitation; greater development in skill awareness than student awareness and self-awareness; and a focus on knowledge-centered learning environments for future classroom teaching experiences.

Keywords: Doctoral students; Future faculty; Graduate students; STEM; Teaching development

> *"Teaching is not easy."*
> *"Teaching preparation takes more time than you think."*
> *"It is harder than I expected to talk and write at the same time."*
> *"I found myself elated in seeing the students using the information I taught."*
> —Excerpts from STEM future faculty's teaching reflections

Graduate school is an important time for future faculty socialization into academia, but Austin (2002) identified gaps such as the need for doctoral students to learn about faculty work and receive feedback from current faculty. According to the Association of American Colleges and Universities (Adams, 2002), graduate student professional development in teaching is important to prepare future faculty. However, graduate schools do not always provide opportunities for graduate students to train and develop as future faculty in academia. Teaching opportunities are limited, and according to Davis and Kring (2001), researchers have also expressed concern about the use of such opportunities. When graduate students have the opportunity to teach, they may experience tension between teaching and research practice (Dotger, 2011) and between teaching and epistemology (Kinchin, Hatzipanagos, & Turner, 2009).

Graduate students, including those in science, technology, engineering, and mathematics (STEM) fields, frequently aspire to higher education faculty positions requiring teaching; however,

discipline-related course work and research do not provide the required pedagogy, strategies, and skills. At the same time, faculty search requirements are increasing because educational institutions are looking for individuals with teaching experience who have taken courses focused on pedagogy and teaching in higher education (Adams, 2002). Future faculty must provide teaching evidence and pedagogical knowledge to compete in today's academic job market. Boice (2000) found that when future faculty become new faculty, classroom experiences are often the difference between success and failure in academia. Specifically, novice teachers often prepare too much material, at too difficult a level, and present material too quickly. Furthermore, they frequently do not connect with students, focusing on content and excluding the process of teaching and learning.

Furthermore, STEM future faculty will influence the future of science, technology, engineering, and mathematics education. According to the National Science Foundation (2009), "future faculties will be engaged in all forms of STEM education for diverse learners, including college classrooms and laboratories, distance learning, K–12 preservice preparation, and informal education" (p. 1). Therefore, graduate school is a critical time to develop teaching to, ultimately, enhance STEM education at all levels.

In response to concerns about graduate student professional development as well as student and program requests, a large southwestern research university assessed and designed a program specific to teaching development. Rationale included advancing the university's graduate programs and students' career development as well as enhancing undergraduate education. Internal and external
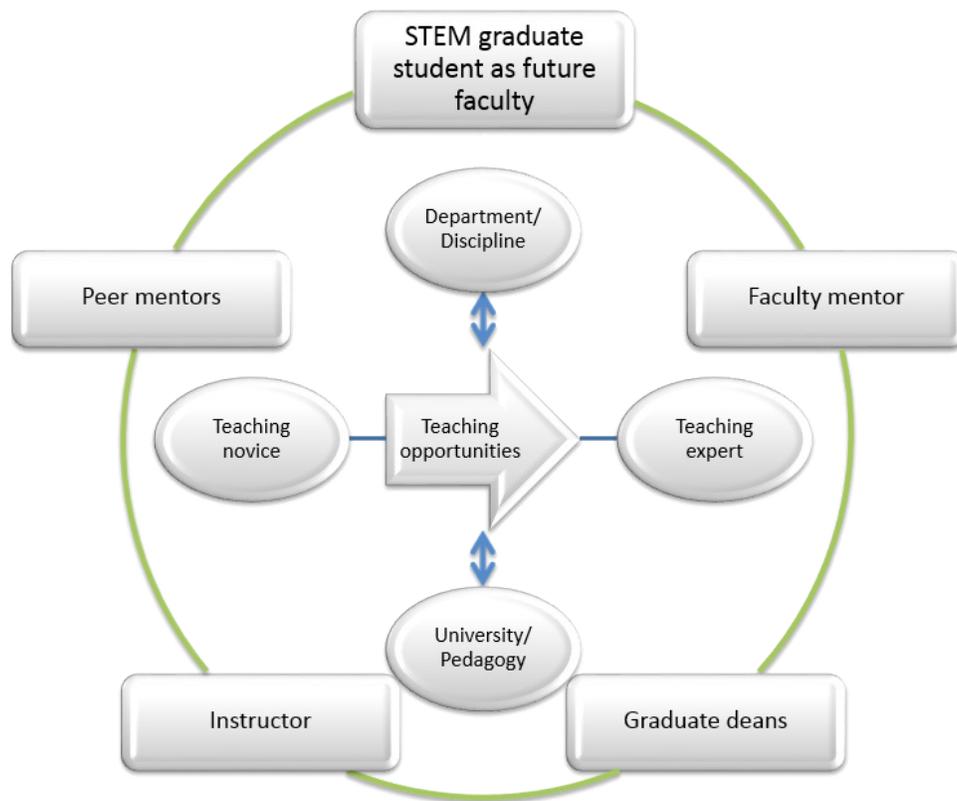

Figure 1. Conceptual model of graduate student professional development in teaching (Cherrstrom et al., 2012) applied to the STEM teaching development course.

research yielded a conceptual model of graduate student professional development in teaching. The purpose of this study was to examine future faculty's perceived teaching development during a semester-long STEM teaching development course.

Conceptual Framework

For the STEM teaching development course and associated study, instructors and researchers adapted the conceptual model of graduate student professional development in teaching (Cherrstrom, Fowler, & Richardson, 2012) and the course design cycle (Fowler, Sandoval, Layne, & Macik, 2011) as a framework.

Graduate Student Professional Development in Teaching

The adapted conceptual model of graduate student professional development in teaching's core (see Figure 1) depicts a progression (Prieto & Meyers, 2001) from *teaching novice* toward *teaching expert*, which requires teaching opportunities. Whereas novices struggle to construct meaning from new information, experts make connections, identify patterns, and organize and process information into new solutions (Bransford, Brown, & Cocking, 2000). As graduate students begin the progression from teaching novices, they begin a lifetime journey toward teaching experts. Such progressions necessitate departmental partnerships for access to discipline-specific academic and pedagogical content (Ronkowski, 1998) and university-wide programs for knowledge and resources in teaching and learning (Mintz, 1998). The model's outer layer depicts this study's key stakeholders, comprising the STEM graduate student as future faculty, his or her faculty mentor (Kost, 2008; Park, 2004), other graduate students as peer mentors (Davis & Kring, 2001; Harris, Froman, & Surles, 2009), the course instructor, and their graduate dean.
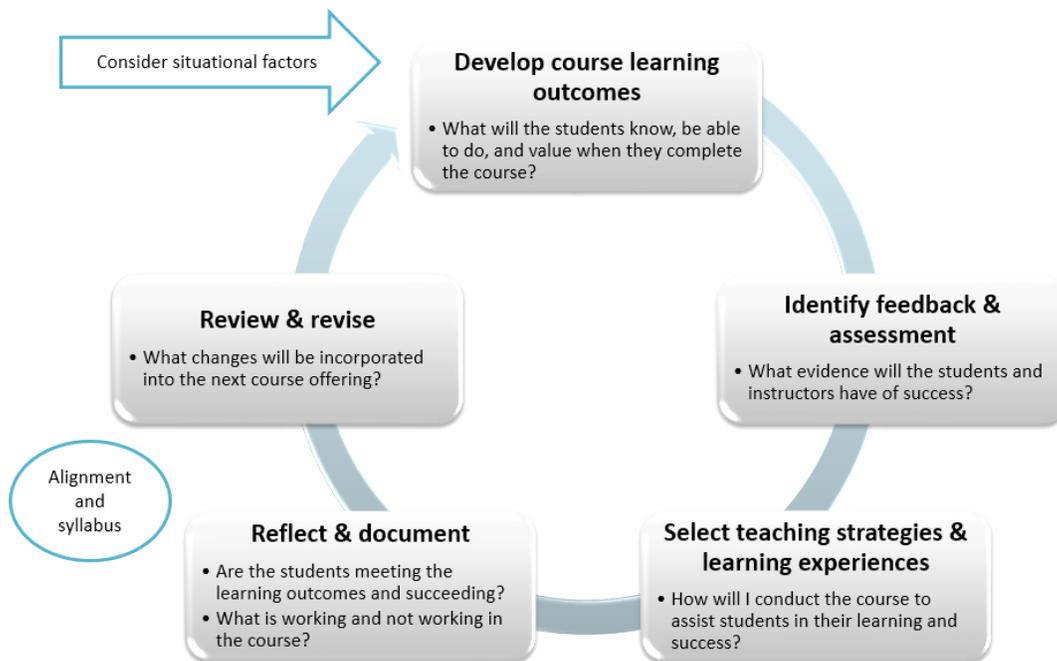

Figure 2. Course design cycle (Fowler et al., 2011).

Course Design Cycle

In addition, instructors used the university's teaching development center's five-step course design cycle (see Figure 2) to design the STEM teaching development course. As part of the course, they also presented the cycle to STEM future faculty as an instructional design tool for their course assignments and future teaching activities. Guided by the model and cycle as a framework, instructors developed and created teaching opportunities within a new STEM course.

STEM Teaching Development Course

To foster STEM future faculty's progression from teaching novices toward teaching experts, the university's teaching development center and two STEM-related colleges (engineering and science) partnered to create and facilitate a STEM teaching development course. The teaching development center provided instructional design, cofacilitation, and expertise in general pedagogy. Graduate deans in the participating colleges secured funding from the university's graduate studies office to support the course. In some cases, the funding compensated students or programs for lost research assistant time because most participants were advanced doctoral students actively involved in research projects. In addition, the graduate deans recruited STEM faculty as expert mentors to create teaching opportunities within their courses and guide the novice STEM future faculty. This mentor–novice pairing was central to the course's design, and faculty mentors cofacilitated with instructors to deliver discipline-specific pedagogy and content. The resulting one semester credit hour, blended learning course met six Friday afternoons throughout the spring semester in a 2-hour workshop format, which was supplemented with online learning content, group learning activities, and discussions.

Following the course design cycle (see Table 1), instructors prepared by analyzing the STEM teaching development course's situational factors, specifically the context of the course, institution, environment, students, and instructor (Fink, 2005). For course design, they first developed four learning outcomes. Second, to assess such outcomes, they identified feedback and assessment methods (described below). Third, they selected teaching strategies and learning experiences, including lecture, activities, small- and large-group discussion, reflective writing, and designing and teaching a lesson. After verifying the alignment of learning outcomes, assessments, and strategies or learning experiences, instructors finalized the course syllabus (see Table 2 for topics and essential questions). Fourth, instructors reflected on the course design process, their experiences, and STEM faculty assessments. Last, after verifying alignment among the steps and an organized syllabus, they conducted this study to enhance reflection and documentation, leading to course review and revision.

Course Assignments

The course included formative and summative course assignments. Formative assignments comprised a pre- and post-knowledge survey and Brookfield's (2006) Critical Incident Questionnaires to identify what aspects of each classroom session were most engaging, distancing, affirming, puzzling, and surprising to STEM future faculty. Summative assessments comprised four assignments (see Figure 3), which instructors graded using rubrics. The final course grade was pass or fail with pass defined as 75% or greater on the grading scale.

As the first assignment, STEM future faculty drafted a teaching philosophy statement prior to the course's second session that was based on session one and the assigned readings. As stated

in the syllabus, "documenting your teaching philosophy is a highly reflective process regarding what teaching and learning mean to you" (Autenrieth & Fowler, 2012, p. 2). Two months later, the STEM future faculty finalized their teaching philosophy statements after receiving instructor feedback on the drafts, participating in additional course sessions, and completing their classroom teaching experiences.

Table 1
Course Design Cycle Applied to STEM Teaching Development Course

Course design cycle	Applied to STEM teaching development course design
Preparation: Situational factors (Fink, 2005)	Context • Course: Graduate-level elective in colleges of engineering and science • Institution: Large, southwest research institution • Environment: Classroom workshops and online • Students: STEM graduate students interested in positions requiring teaching experience • Instructor: Associate director of university's teaching development course, associate deans, faculty mentors
1. Develop learning outcomes	By the end of the course, STEM future faculty will be able to • develop a reflective and purposeful approach to teaching • develop a teaching philosophy statement • practice self-assessment and peer assessment of teaching • apply principles of integrated course design in the development of a course within their discipline
2. Identify feedback & assessment methods	• Formative assessments ▪ Pre- and post-knowledge surveys ▪ Critical Incident Questionnaires (Brookfield, 2006) • Summative assessments ▪ Drafted (15%) and final (15%) teaching philosophy statements ▪ Multifaceted classroom teaching experience (40%) ▪ Syllabus for proposed class in future faculty's discipline (30%)
3. Select teaching strategies & learning experiences	• Lecture • Activities ▪ Small- and large-group discussion ▪ Reflective writing ▪ Designing and teaching a lesson
4. Reflect & document	• Critical Incident Questionnaires (Brookfield, 2006) • Course assignments
Alignment and Syllabus	
5. Review & revise	• Instructor reflection • This study's findings • Course revision

Table 2
Session Schedule for STEM Teaching Development Course

Face-to-face session	Topic(s)	Essential question(s)
Session 1: Late January	• Course intro: What will the semester bring? • Knowledge survey • Course Design Cycle • Teaching philosophy	• Who are we as a cohort and how will that support our learning experience? • What do I know about college teaching and student learning? • How do we promote learning through informed course design?
Session 2: Mid-February	• Situational factors/learning outcomes • Blooms Taxonomy	• Who are we teaching? • What do we expect from them?
Session 3: Late February	• Intellectual development of scientists and engineers	• How does the intellectual development of undergraduate students effect how we teach?
Late February to late March	• Individual consultations with faculty and CTE (optional) • Classroom teaching experiences	• Where do I begin my design? • Who will I be teaching?
Session 4: Late March	• Assessment and rubrics • Student experiences/teaching methods	• How do we know when the expectations have been met and how do we communicate that to students? • How can we best utilize class time?
Session 5: Mid-April	• Reflection and feedback on our teaching • Teaching as research • Peer review	• How can we use reflection to integrate what we've learned and deepen our understanding of learning and good teaching?
Session 6: Late April	• Syllabus development • Final peer review—key learning experiences • Special topics	• How does the type of class influence how we teach? • How do we create an environment that is welcoming for all learners?

The second assignment, the multifaceted classroom teaching experience, was the course's central focus. STEM future faculty analyzed situational factors and used the course design cycle to create and implement a lesson for a course in their discipline. Specifically, they began by thinking about what they wanted students to learn during the lesson and formulated learning outcomes. Although it is challenging to incorporate feedback and assessment into one lesson, instructors encouraged STEM future faculty to do so in order to determine if students achieved the learning outcome. In addition, because teaching strategies tended toward lecture, instructors encouraged STEM future faculty to engage learners in some way during the lesson.

Most STEM future faculty implemented the lesson in their faculty mentor's undergraduate
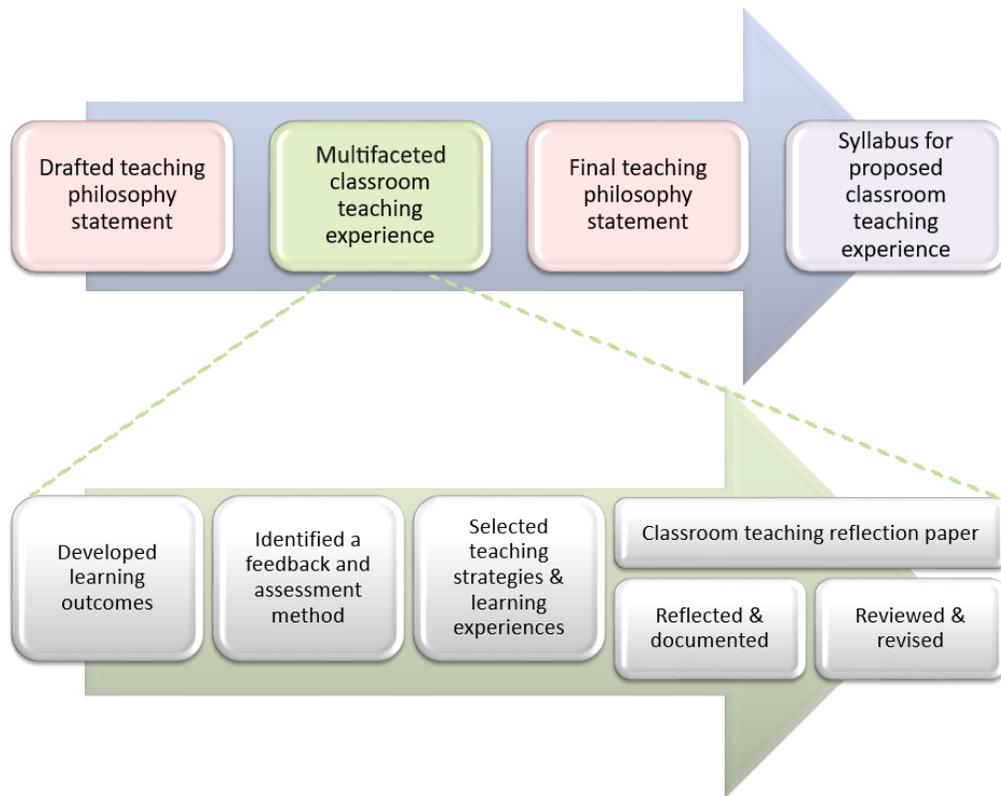
Figure 3. Four summative assessments for the STEM teaching development course (top arrow). The second assessment, multifaceted classroom teaching experience, included several components (bottom arrow).

classroom, but a few taught a graduate seminar or group of volunteer graduate students. STEM future faculty engaged in peer review, observing and providing feedback on the classroom teaching experience of at least two peers. As a result, each STEM future faculty member received feedback from two peers, the course instructors, and some faculty mentors. Last, STEM future faculty wrote a classroom teaching reflection paper based on their experience and feedback, including how they would teach the lesson differently the next time.

For the final assignment, STEM future faculty created a syllabus for a proposed discipline-specific course. In addition, they developed a rationale for the course and identified where it would fit into a larger program or degree. In addition to sharing information about a course, the syllabus facilitates instructor–student communication, including anticipating and addressing course issues (Eberly, Newton, & Wiggins, 2001). The syllabus assignment required STEM future faculty to begin with situational factors (Fink, 2005), develop learning outcomes, identify feedback and assessment methods, and select teaching strategies and learning experiences, including lesson content. Such course assignments inspired us to conduct this qualitative case study to improve the course and share findings.

Research Design

A qualitative case study methodology supported the study's purpose: to examine future faculty's perceived teaching development during a semester-long STEM teaching development course. Qualitative research seeks to understand the meaning-making process, how people make sense

of their lives and interpret their experiences (Merriam, 1991). In this Institutional Review Board approved study (IRB2012-0029D), we were interested in understanding how graduate students perceived their teaching development construction and interpreted their teaching experience. Case study qualitative research explores a real-life bounded system over time (Creswell, 2013), in this study, that was the STEM teaching development course.

Course participants included 24 doctoral students who registered for the STEM teaching development course, 15 of whom participated in and completed the study. The doctoral students self-selected by registering for the course or were recruited by graduate deans or faculty members. The teaching development center and participating colleges intended the course to target advanced doctoral students who had passed preliminary exams and were nearing their dissertation defense. The resulting STEM future faculty participants represented the full range of doctoral students from finishing course work to defending proposals and dissertations to applying for faculty positions. In addition, 21 current STEM faculty members, eight of whom participated in the study, mentored the graduate students.

To examine STEM future faculty's perceived teaching development, data collection comprised the course's assigned classroom teaching reflection paper and a STEM future faculty focus group, which was supplemented by a faculty mentor survey. In the classroom teaching reflection paper, 15 STEM future faculty reflected on open-ended questions about their classroom teaching experience and peer, instructor, and mentor feedback. The following were questions from the classroom teaching reflection paper: (1) "What was the most significant thing you learned in the course," (2) "what did you learn by conducting the teaching session," and (3) "considering how the teaching session went, what would you do differently and why?" In addition, four graduate students participated in a postsemester focus group. During the 1-hour focus group interview, coresearchers used a semistructured interview guide to ask open-ended questions and recorded answers. Last, eight faculty mentors responded to an anonymous online survey consisting of open-ended questions at semester end.

Data analysis consisted of multiphase content analysis to interpret meaning from the collected data as well as systematic coding and identifying themes. To begin, we collected, organized, and read all the data in their entirety to gain an overall sense of the data. For the classroom teaching reflection papers, we identified individual item statements using Chi's (1997) process to quantify qualitative analyses of verbal data. Next, we used conventional and directed content analysis to systematically code and identify categories (Hsieh & Shannon, 2005). Specifically, for the first and second reflection questions, we used conventional content analysis with codes and categories emerging from the data. For the third reflection question, we manually used directed content analysis with codes and themes developed from relevant theory. Using the resulting coded individual item statements, we transformed qualitative data into quantitative data, represented by categories and counts of individual item statements. Similarly, for the focus group and survey data, we coded individual item statements and identified major categories; however, due to the small sample size, we did not perform quantitative data analyses. This data analysis resulted in the study's findings.

Discussion and Recommendations

The purpose of this study was to examine future faculty's perceived teaching development during a semester-long STEM teaching development course. The STEM teaching development course created opportunities for future faculty to teach in a classroom; engage with experienced

STEM instructors, mentors, and deans; and begin their progression from teaching novice to teaching expert. Logically, asking STEM future faculty to design and teach a classroom learning experience would be beneficial to their pedagogical development, but how did they perceive their teaching development? This section discusses the findings, which are organized by three questions from the classroom teaching reflection papers, and offers recommendations.

Based on the data analysis, we identified three themes related to future faculty's perceived teaching development during a semester-long STEM teaching development course: (a) teaching confidence and skill development, (b) greater skill awareness than student awareness and self-awareness, and (c) a focus on knowledge-centeredness for future classroom teaching experiences.

Teaching Confidence and Skill Development

The first reflection question asked, "What was the most significant thing you learned in the course?" The main themes identified from the responses of STEM future faculty in this study were teaching confidence and skill development in instructional design, preparation, and facilitation (see Table 3). The faculty mentor surveys provided insight into how the course supported such teaching confidence and skill development. For example, according to faculty mentors, the course:

- "provided the tools for my student to be successful teaching in the future,"
- "gave [students] a broad overview of teaching and permitted them an opportunity to develop a course before they actually have to do it for real,"
- "improved their writing and encouraged them to think about their approach to teaching," and
- "helped [STEM future faculty] to be better prepared when going to the academic job market."

One faculty mentor highlighted the difference between *learning and teaching*:

Students were able to see the amount of effort one can put into teaching and the positive payoff associated with that effort. They were also able to see that "learning" is not the equivalent of "teaching."

Table 3

Teaching Confidence and Skill Development

Theme		Select student excerpts
Teaching confidence		"Confidence, I can teach." "I have more confidence now." "I do have the ability and confidence to teach."
Skill development in	Instructional design	"Do not provide too much material." "Students appreciate interactive learning." "I would remove some slides to provide more time for discussion."
	Preparation	"I learned preparation is a lengthy process." "Prior planning is a must." "I learned a lot on how to prepare a course and some mistakes to avoid."
	Facilitation	"Speak s-l-o-w-l-y." "I kept a clock on my personal laptop to keep track of time." "Enthusiasm of the instructor can be motivating to students."

Note. Reflection Question 1: "What was the most significant thing you learned in the course?"

The next two sections describe specific findings related to awareness during instructional practices as well as attributes of designing environments for optimized learning.

Skill Awareness, Student Awareness, and Self-Awareness

The second reflection question asked, "What did you learn by conducting the teaching session?" The main theme identified from responses to this question regarded STEM future faculty's perceived skill awareness, student awareness, and self-awareness (see Table 4). Specifically, they reported greater skill awareness than student awareness and self-awareness. This question's greater skill awareness parallels the first reflection question's skill development. Although future faculty did perceived student awareness and self-awareness, future course enhancements could help to improve STEM future faculty's awareness in those two areas.

Student awareness is vital to designing learning environments, supports student achievement (Bransford et al., 2000), and contributes to new faculty success (Boice, 2000). Understanding students' prior knowledge (including preconceptions and misconceptions), expectations, and goals helps instructors design optimized learning environments by considering the diversity of learners. Furthermore, when future faculty become new faculty, classroom experiences are often the difference between success and failure in academia (Boice, 2000). For example, new faculty often do not connect with students, focusing on content and excluding the process of teaching and learning.

STEM future faculty could enhance their students' learning experiences by maintaining a purposeful awareness of students. To improve such student awareness, we recommend greater emphasis and time spent considering the situational factors: context of the course, institution, environment, students, and instructor (Fink, 2005). Furthermore, we recommend that STEM future faculty develop a data-driven decision-making approach to student awareness. Multiple data types can inform STEM future faculty's decisions regarding instructional approach, pace, and focus in the classroom. Specifically, systematic data application and analysis from low-stakes classroom assessments (Angelo & Cross, 1993) provide information about students' prior knowledge and reactions to content and instruction. For example, the background knowledge probe (assessing

Table 4
Three Areas of Teaching Awareness

Theme		% of individual item statements	Examples
Awareness	Skill	50%	time management, lesson planning, instructional methodology, technology-enhanced instructional practices, and facilitation challenges
	Student	30%	learning motivators, multimodal aspects of knowledge acquisition, attitudes and behaviors toward learning, and prior experience with the content material related to knowledge construction
	Self	20%	evaluative sense of self as related to personal speech patterns; personal assumptions, idealist expectations, and preferences (biases); confidence and assurance; and metacognitive practices

Note. Reflection Question 2: "What did you learn by conducting the teaching session?"

student's prior knowledge) and teacher-designed feedback forms (assessing students' reactions to content and instruction) may increase STEM future faculty's awareness of how students are experiencing learning and improve student success in the classroom.

Self-awareness is also instrumental in designing learning environments (Bransford et al., 2000). For example, Brookfield (2006) suggested "that skillful teaching is a highly variable process that changes depending on any number of contextual factors" (p. 17), including instructor beliefs and assumptions about and styles of teaching. To develop STEM future faculty's self-awareness, we recommend more proactive and deliberate instructional practices. Specifically, exercises supporting critical reflection may prove instrumental in increasing self-awareness in STEM future faculty. For example, the role model profile (Brookfield, 1995) asks instructors to think about an ideal teacher from the past and answer four questions about his or her teaching styles, abilities, and actions. Talking about teachers whom we admire and why we admire them alerts us to prescriptive assumptions that frame our teaching practice. In addition to responding to Critical Incident Questionnaires (Brookfield, 2006), as students in the teaching development course, STEM future faculty can use such questionnaires to collect, analyze, and reflect on formative feedback from their students. Last, engaging STEM future faculty in small- or large-group debriefs about critically reflective aspects of teaching may support the application of pedagogical theory in learning experiences. Although the nature may vary, these debriefs prompt STEM future faculty to discuss elusive questions such as "How are students experiencing learning in my classroom?" and "How effectively am I teaching?"

Knowledge-Centered Learning Environment

The third reflection question asked, "Considering how the teaching session went, what would you do differently and why?" Designing learning environments in higher education is significant and relevant to STEM future faculty's professional development in teaching. The Committee on Developments in the Science of Learning (Bransford et al., 2000) identified "four interrelated attributes of learning environments that need cultivation" (p. 23). Their framework for optimizing learning calls for: knowledge-centered, assessment-centered, learner-centered, and community-centered learning environments. Knowledge-centered learning environments support teaching in ways that lead to student learning, understanding, and transfer of such learning and understanding to new contexts. Assessment-centered learning environments offer students multiple opportunities for feedback and to revise assignments. Learning-centered environments incorporate students' skills, attitudes, and beliefs into the lesson cycle. Last, in community-centered learning environments, students feel connected to each other and the larger civic community related to learning. Expert teachers skillfully leverage all four attributes.

In this study, STEM future faculty predominately reflected one attribute, knowledge-centeredness, missing the other three attributes and the powerful interrelationship among all four attributes in designing learning environments (see Table 5). This could result in a distorted view of and approach to instructor and student practices in the classroom. To address this challenge, we recommend using intentional and deliberate practices to instruct students in the balanced design of STEM learning environments, including the effective management of all attributes. For example, to foster assessment-centeredness, we suggest reinforcing formative and summative assessments as part of the classroom teaching experiences. To foster learner-centeredness, we suggest applying recommendations from the earlier discussion of student awareness. Last, community-centeredness

Table 5

Four Interrelated Attributes of Designing Environments for Optimized Learning (Bransford et al., 2000)

	Theme	% of individual item statements	Focus and opportunity
Centeredness	Knowledge	63%	STEM future faculty would augment one or more aspects of their learning environments related to knowledge
	Assessment	7%	Development opportunity
	Learner	3%	
	Community	3%	

Note. Reflection Question 3: "Considering how the teaching session went, what would you do differently and why?"

may have been low due to designing and facilitating a single classroom teaching experience. To foster this attribute, we recommend adding a more explicit community learning experience in the STEM teaching development course and incorporating a community learning experience into their classroom teaching experiences.

Additional Course Recommendations

Based on the findings and our teaching reflections, we recommend four additional course design changes to enhance STEM future faculty's teaching development. First, to increase faculty mentor and peer mentor interaction, incorporate small-group discussion during the six face-to-face sessions. Small-group discussions create opportunities for STEM future faculty to ask questions and share ideas. Second, increase the number of teaching opportunities from one to two by having STEM future faculty teach their small groups a current teaching and learning topic during class time in addition to their discipline-specific lesson. Third, videotape the classroom teaching experience and utilize stimulated recall to facilitate STEM future faculty's review, self-reflection, and discussions with their faculty mentor. Videotape review will assist STEM future faculty in identifying their implicit beliefs about teaching that could influence their classroom teaching (Meade & McMeniman, 1992). Last, we recommend assigning an e-portfolio with reflective prompts to house a student's course artifacts, enhance student reflection throughout the course, and provide evidence of teaching. Based on the study's findings, we offer implications and directions for future research.

Implications and Future Research

The STEM teaching development course case study offers implications for theory and practice and directions for future research. In regard to theory, the study expands the literature beyond teaching assistants to include nonteaching graduate students and the novice to expert literature with a focus on teaching in general and graduate students specifically. In regard to practice, the study contributes to instructional design in graduate student professional development in teaching. The course is an example of how to create learning opportunities for future faculty teaching novices as they develop towards teaching experts. Directions for further research includes similar studies within and beyond the STEM fields of future faculty development in teaching. Such studies may

include using different combinations of the conceptual model's components for graduate student professional development in teaching, for example, various or additional teaching strategies and methods. Furthermore, execution of the additional course recommendations discussed above merits further study.

Conclusion

In summary, graduate school is an important time for future faculty to develop teaching skills, but teaching opportunities are limited. Discipline-related course work and research do not provide the pedagogy, strategies, and skills to effectively teach and compete for higher education jobs. When future faculty become new faculty, efficient and effective teaching saves time and supports success. In addition, STEM future faculty will influence the future of science, technology, engineering, and mathematics. The purpose of this case study was to examine future faculty's perceived teaching development during a semester-long STEM teaching development course. Findings included STEM future faculty teaching confidence and skill development in instructional design, preparation, and facilitation; greater development in skill awareness than student awareness and self-awareness; and a focus on knowledge-centered development for future classroom teaching experiences.

References

Adams, K. A. (2002). *What colleges and universities want in new faculty*. Washington, DC: Association of American Colleges & Universities.

Angelo, T. A., & Cross, K. P. (1993). *Classroom assessment techniques: A handbook for college teachers* (2nd ed.). San Francisco, CA: Jossey-Bass.

Austin, A. E. (2002). Preparing the next generation of faculty: Graduate school as socialization to the academic career. *Journal of Higher Education*, *73*(1), 94–122. doi:10.1353/jhe.2002.0001

Autenrieth, R., & Fowler, D. (2012). *Special topics in STEM teaching professional development* [Course syllabus]. College Station: Center for Teaching Excellence, College of Engineering, and College of Science, Texas A&M University.

Bransford, J. D., Brown, A. L., & Cocking, R. R. (Eds.). (2000). *How people learn: Brain, mind, experience, and school* (Expanded ed.). Washington, DC: National Academy Press. doi:10.17226/9853

Boice, R. (2000). *Advice for new faculty members: Nihil nimus*. Needham Heights, MA: Allyn and Bacon.

Brookfield, S. D. (1995). *Becoming a critically reflective teacher*. San Francisco, CA: Jossey-Bass.

Brookfield, S. D. (2006). *The skillful teacher: On technique, trust, and responsiveness in the classroom* (2nd ed.). San Francisco, CA: Jossey-Bass.

Cherrstrom, C. A., Fowler, D., & Richardson, R. (2012, October). *Graduate student professional development in teaching—Interdisciplinary & blended learning*. Concurrent session conducted for the 37th Annual Conference of the Professional and Organizational Development (POD) Network in Higher Education, Seattle, WA.

Chi, M. T. H. (1997). Quantifying qualitative analyses of verbal data: A practical guide. *The Journal of the Learning Sciences*, *6*(3), 271–315. doi:10.1207/s15327809jls0603_1

Creswell, J. W. (2013). *Qualitative inquiry & research design: Choosing among five approaches* (3rd ed.). Thousand Oaks, CA: Sage.

Davis, S. F., & Kring, J. P. (2001). A model for training and evaluating graduate teaching assistants. *College Student Journal*, *35*(1), 45–51.

Dotger, S. (2011). Exploring and developing graduate teaching assistants' pedagogies via lesson study. *Teaching in Higher Education*, *16*(2), 157–169. doi:10.1080/13562517.2010.507304

Eberly, M. B., Newton, S. E., & Wiggins, R. A. (2001). The syllabus as a tool for student-centered learning. *The Journal of General Education*, *50*(1), 56–74. doi:10.1353/jge.2001.0003

Fink, D. L. (2005). *Integrated course design* (IDEA Paper No. 42). Manhattan, KS: The IDEA Center. Retrieved from http://www.ideaedu.org/Portals/0/Uploads/Documents/IDEA%20Papers/IDEA%20Papers/Idea_Paper_42.pdf

Fowler, D., Sandoval, C., Layne, J., & Macik, M. (2011). *Course design cycle*. Retrieved from http://cte.tamu.edu/getattachment/Faculty-Teaching-Resource/Course-Design/Fowler-et-al-2011-Course-Design-Cycle.pdf.aspx

Harris, G., Froman, J., & Surles, J. (2009). The professional development of graduate mathematics teaching assistants. *International Journal of Mathematical Education in Science and Technology*, *40*(1), 157–172. doi:10.1080/00207390802514493

Hsieh, H.-F, & Shannon, S, E. (2005). Three approaches to qualitative content analysis. *Qualitative Health Research*, *15*(9), 1277–1288. doi:10.1177/1049732305276687

Kinchin, I. M., Hatzipanagos, S., & Turner, N. (2009). Epistemological separation of research and teaching among graduate teaching assistants. *Journal of Further and Higher Education*, *33*(1), 45–55. doi:10.1080/03098770802638267

Kost, C. R. (2008). Innovations in teaching assistant development: An apprenticeship model. *Foreign Language Annals*, *41*(1), 29–60. doi:10.1111/j.1944-9720.2008.tb03278.x

Meade, P., & McMeniman, M. (1992). Stimulated recall—An effective methodology for examining successful teaching in science. *Australian Educational Researcher*, *19*(3), 1–18. doi:10.1007/BF03219515

Merriam, S. B. (1991). How research produces knowledge. In J. M. Peters & P. Jarvis (Eds.), *Adult education: Evolution and achievements in a developing field of study* (pp. 42–65). San Francisco, CA: Jossey-Bass.

Mintz, J. A. (1998). The role of centralized programs in preparing graduate students to teach. In M. Marincovich, J. Porstko, & F. Stout (Eds.), *The professional development of graduate teaching assistants* (pp. 19–40). Bolton, MA: Anker.

National Science Foundation. (2009). *The CIRTL Network: Shaping, connecting, and supporting the future national STEM faculty: 2009 annual report*. Arlington, VA: Author.

Park, C. (2004). The graduate teaching assistant (GTA): Lessons from North American experience. *Teaching in Higher Education*, *9*(3), 349–361. doi:10.1080/1356251042000216660

Ronkowski, S. A. (1998). The disciplinary/departmental context of TA training. In M. Marincovich, J. Porstko, & F. Stout (Eds.), *The professional development of graduate teaching assistants* (pp. 41–60). Bolton, MA: Anker.

Prieto, L. R., & Meyer, S. A. (Eds.). (2001). *The teaching assistant training handbook: How to prepare TAs for their responsibilities*. Stillwater, OK: New Forums Press.

Authors

Catherine A. Cherrstrom, Assistant Professor of Occupational, Workforce, and Leadership Studies, Texas State University; cac424@txstate.edu

Ra'sheedah Richardson, Instructional Consultant for the Center for Teaching Excellence, Texas A&M University; sheedah@tamu.edu

Debra Fowler, Director of the Center for Teaching Excellence, Texas A&M University; dfowler@tamu.edu

Robin Autenrieth, Head of the Zachry Department of Civil Engineering and A.P. and Florence Wiley Professor III, Texas A&M University; rautenrieth@civil.tamu.edu

Mark J. Zoran, Professor and Associate Dean for College of Science, Texas A&M University; zoran@bio.tamu.edu