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How Student-led Organizations Shape STEM Preservice Teachers' Sense of Belonging

Uchenna Emenaha Miles
The University of Texas at San Antonio, USA

Samantha Leihsing
The University of Texas at San Antonio, USA

Janet Solis Rodriguez
The University of Texas at San Antonio, USA

ABSTRACT

Student organizations have been shown to have positive effects on students' wellbeing and academic achievement. This study examines how student-led organizations within a STEM teacher preparation program shape students' sense of belonging among 27 undergraduate STEM preservice teachers following the COVID-19 pandemic. Our analysis revealed that participation in student-led organizations was associated with increases in students' sense of belonging, socioemotional wellbeing, academic outcomes, and connection to the teaching profession. These findings suggest that student-led organizations can play a pivotal role in fostering prospective teachers' sense of belonging by creating supportive communities that cultivate their professional growth as they prepare to enter the STEM teaching workforce.

Keywords: Belongingness, Postpandemic, Preservice Teachers, Sense of belonging, STEM, Student organizations

Editors:
Grant Clayton, Associate Professor, University of Colorado Springs, USA
Krishna Bista, Professor, Morgan State University, Baltimore, USA

INTRODUCTION

Studies have shown that the sense of belonging among preservice teachers (PSTs) decreased during the COVID-19 pandemic (Appleby et al., 2022; Heider, 2021). One reason for the decline was the absence of social communities, such as student clubs and organizations, that catered to students' sense of belonging through engagement with peers and faculty within the university (Kelly et al.,2024; Tice et al., 2021; Skipper & Fay, 2023). Another was the sudden transition to online learning during the COVID-19 pandemic, which increased social isolation among students (UNESCO, 2020; Tice et al., 2021; Kelly et al., 2024). These factors underscore the importance of understanding how to increase students' sense of belonging through supportive social communities, such as student-led organizations (SOs), particularly for preservice STEM (science, technology, engineering, and math) teachers, given that math and science subjects are among the most understaffed teaching areas in K-12 education (Sutcher et al., 2019).

SOs are formed and led by students, who collectively define their organization's mission based on needs within their student community and work together to carry out their SO mission (Jones & Glies, 2022). SOs have multiple benefits for students, including increasing their well-being, academic success, and sense of belonging to the university and school community (Bond & Sterrett, 2014; De Sisto M et al., 2021). SOs have existed since early colonial times and have evolved to support a wide range of special interests and topics, including academic pursuits, affinity groups, and sports clubs (Dunkel et al., 2014). However, although various forms of SOs have been around for years, few studies have explored how they shape PSTs' sense of belonging as they prepare to enter the teaching workforce.

Belongingness, or sense of belonging, is defined as the degree of social connections an individual feels within a given social context and is also considered a fundamental human need (Baumeister & Leary, 1995; Cueto, et al., 2009; Osterman, 2000). Having a strong sense of belonging to a group influences students' sense of meaning, identity, and relevance (Allen, 2020, Tinto, 1975). Furthermore, research indicates that increases in students' sense of belonging support their connectedness to institutions, as well as higher retention and persistence rates among PSTs (Bjorklund, et al, 2021). PSTs with a greater sense of belonging are more likely to persist in the teaching profession and take on roles as teacher leaders (Bond, 2011; Bjorklund, et al, 2021). A strong sense of belonging among PSTs has also been linked to increased well-being, open-mindedness, creativity, and the ability to handle stress (Bjorklund et al., 2021). All of these factors are particularly important considering the growing need for STEM teachers

across schools in the U.S., as well as the high rates of teachers leaving the field overall (Carver-Thomas & Darling-Hammond, 2017).

While prior studies have examined the role that a sense of belonging plays in PST teaching experiences (Johnston & Dewhurst, 2021; Bjorklund et al, 2021) and how it influences students in STEM subjects (Chaffee et al., 2025; Feser & Plotz, 2023), few studies have explored how SOs help shape PSTs' sense of belonging in the teacher workforce (Johnston & Dewhurst, 2021), particularly in STEM fields. This study adds to the growing literature on SOs and PSTs but focuses on how SOs can help support PSTs' sense of belonging in the STEM teacher workforce. These findings have important implications for teacher candidates' sense of belonging, not only in their success as university students but also as future teachers.

PURPOSE OF THE STUDY

The study focuses on an SO situated in a UTeachSA program, a STEM teacher preparation program at the University of Texas at San Antonio, which is a large urban Hispanic-serving university. The study examines the experiences of PSTs enrolled in the UTeachSA program, which is part of the UTeach Institute. The UTeach Institute houses the nationally recognized UTeach STEM teacher preparation program, which is replicated across 23 states in the U.S. as well as the District of Columbia. Students enrolled in the UTeach STEM teacher preparation program pursue STEM degrees (i.e., math, science, or computer science) while also taking pedagogical courses to obtain their teaching credentials upon graduation. Graduates of the program are considered highly qualified teachers in their field and are also associated with achieving higher student gains than teachers from other programs are (Backes et al., 2018). Additionally, nearly 70% of program graduates teach in under resourced schools, with over 80% remaining in the teaching profession beyond the first five years (UTeach Institute, 2024).

The UTeachSA program, where the present study was conducted, was established in 2006 and created its first SO in 2016 but closed it during the COVID-19 pandemic. In response to the university's calls to increase students' well-being and belonging, the UTeachSA faculty decided to reestablish the SO as a student support system for PSTs in STEM. The faculty in the UTeachSA program recruited student leaders who would serve as the organization's officers and help grow the organization. In this study, we explored how SOs support PSTs' sense of belonging not only within the university but also to the STEM teaching profession.

Research Questions

1) What factors contribute to STEM preservice teachers' desire to join the student organization?

2) In what ways are STEM preservice teachers supported in their sense of belonging through their participation in a student organization?

LITERATURE REVIEW

In this section, we review the literature on how student organizations, school belonging, and leadership influence PSTs' sense of belonging.

Student Organizations & School Belonging

School belonging refers to the extent to which students feel connected to the university ecosystem from the macro level (the institution) to the micro level (i.e., teachers and peers) (Allen et al., 2020). Tinto (1975) suggested that, for students to persist in and complete college programs, they must feel connected and integrated into their university and school community by exhibiting high levels of school belonging. Therefore, if PSTs lack a sense of connection to their school community or experience a low level of school belonging, they are less likely to graduate from the university and enter the teacher workforce.

Examining belongingness among teacher candidates is essential to ensure a strong pipeline of educators to address teacher shortages in STEM. To this end, Wilson et al. (2015) explored the factors that contribute to belonging among STEM majors across five institutions. Their research identified three key areas that are important to consider when examining the sense of belonging among undergraduate STEM majors: classroom belonging, major belonging, and university belonging. In their research, classroom belonging ranks highest at some institutions; however, university belonging was also found to influence students' persistence and completion of STEM degrees (Wilson et al., 2015). Peer belonging can broaden social networks among individuals who share similar identities and life experiences (Campbell-Montalvo, 2023; Gray & Shortlidge, 2025). These observations emphasize the need to foster a sense of belonging at multiple levels within the university ecosystem when considering the retention and success of PSTs, particularly in high-need fields such as STEM.

In another study involving 36 PSTs, Bjorklund et al. (2021) reported that feeling valued and connected to one's teacher preparation program was positively correlated with well-being, a sense of belonging, and positive teacher identity. Similarly, De Sisto et al. (2022) conducted a study with 50 second-year undergraduate students. They reported that students' interactions with peers and faculty increased their sense of belonging by allowing them to leverage their cultural capital through learning about one another's cultures. The participants in the study also reported a greater sense of connectedness to the university and an increased

likelihood of persisting and completing their degree programs (De Sisto et al., 2022), illustrating how strong peer and faculty relationships can deepen students' sense of belonging.

Students must perceive SOs as welcoming places that meet their expectations for the organization to be effective. Effective SOs not only foster a sense of belonging but also allow students to take ownership of their organization through opportunities to lead their peers and lead through community service (Soria, 2003). The leadership component of SOs is a crucial element that has been shown not only to deepen PSTs' sense of belonging but also to equip them with transferable skills that can support them upon entering the workforce.

Student Organizations & Student Leadership

Students' perceptions of student organizations also influence their experiences within an SO. When students perceive that they are acquiring soft skills, such as leadership, collaboration, and community building, they find great value in participating in an SO. Roberts' (2007) study, which involved STEM PSTs and early career STEM in-service teachers, identified which SO attributes most closely resonated with STEM undergraduates. Students reported that SOs offered them opportunities to develop leadership skills and networks, gain informal teaching experiences, and leverage teaching positions postgraduation (Roberts, 2007). In another study, researchers interviewed 21 PSTs who served as officers in honorary professional student organizations to investigate their motivations for joining the organization (Bond & Sterrett, 2014). The participants noted that their ability to develop their leadership skills, deepen their teacher identities, and collaborate with peers and faculty were the primary motivating factors in serving as student leaders within the organization (Bond & Sterrett, 2014). Research also highlights that PSTs have a strong desire to develop leadership skills by participating in SOs, which may also include leading state and/or national professional organizations in the future (Bond, 2011).

THEORETICAL FRAMEWORK

In this study, we also draw on Kuttner's (2023) framework of belonging to conceptualize how an SO shapes PSTs' sense of belonging. Kuttner's framework highlights six interrelated dimensions of belonging: agentic, intersectional, systemic, political, place-based, and right.

An agentic view of belonging emphasizes students' capacity to determine how, when, and to what extent they engage within institutional settings (Kuttner, 2023). In this way, students actively negotiate their participation based on personal motivations and institutional affordances.

Belonging is thus not static; it reflects students' evolving racial, gendered, cultural, and social identities (Baumeister & Leary, 1995). For example, research shows that when educational environments meaningfully acknowledge and affirm racial and gender identities, students are more likely to experience positive outcomes related to their sense of belonging (Espinosa, 2011; Rodriguez & Blaney, 2021).

Systems shape access to resources through both formal policies and informal norms (Kuttner, 2023; Yuval-Davis, 2006). These systems are inherently political in nature, as they encode power relations and determine who is afforded or denied access to spaces of learning and participation (Yuval-Davis, 2006). As such, students' interactions with and within these systems are critical in shaping their experience of belonging. The place-based dimension of belonging focuses on students' connections to physical, cultural, and relational spaces (Riley, 2022). Place refers not only to geographic location but also to the ways individuals interact with, identify with, and derive meaning from their communities (Johnson et al, 2020). A sense of place contributes to students' sense of belonging when they feel rooted, recognized, and valued within local contexts and social networks (Kuttner, 2023).

Finally, belonging is conceptualized as a fundamental human right (Kuttner, 2023). This perspective, grounded in psychological research, posits that the need for belonging is a fundamental human need essential for well-being and survival (Allen, 2020; Allen et al., 2022). As such, institutions, including universities, bear responsibility for fostering inclusive environments where all individuals, regardless of background, are afforded opportunities for meaningful connection, participation, and recognition. Together, these six dimensions (agency, intersectionality, systemic structures, politics, place, and human rights) form a multidirectional and holistic framework for understanding STEM PSTs' sense of belonging.

METHODS

Data and Analysis

This study was conducted during the 2022--2023 academic year, with 27 PSTs enrolled in the UTeachSA STEM teacher preparation program. All PSTs who participated in the SO were given the option to opt in and out of the study at any time without penalty. The interviews were conducted with graduate students who did not work directly with PSTs or the UTeachSA program. All PSTs self-reported their demographic characteristics in a survey (see Table 1).

Table 1: Participant Demographics

Demographic Characteristics	% or M (SD)
Gender	
Female	71%
Male	27%
Race/Ethnicity	
Latine	55%
White	21%
Black/African American	14%
Asian	10%
Age	
Age	24 (11)

Note. The percentages were rounded to the nearest whole number.

We analyzed the data via multistep qualitative analysis and descriptive analysis. The data were collected through six anonymous surveys. Additionally, 7 SO officers were invited to participate in 45-minute semistructured individual interviews and one of two 45-minute semistructured focus group interviews. PSTs completed a survey questionnaire after participating in six SO activities, which included social events, regular meetings, and community-focused events. A repository of data was created by uploading interview transcripts and open-response survey data into NVivo, a qualitative research software. All the qualitative data underwent an iterative coding process by members of the research team. Points of disagreement during the coding process were discussed until a consensus was reached. We began with open coding, followed by axial coding, where we categorized the data into groups or categories on the basis of similarities and identified major themes (Merriam & Tisdell, 2015). The final iteration of codes produced the themes in the findings within this study, and we used direct quotes from participants to support the categories that developed throughout the thematic coding process. We also conducted a descriptive analysis of a Likert-scale survey item to better understand with whom PSTs felt more connected after participating in SO activities.

Trustworthiness & Positionality

Establishing rigor and reliability in qualitative research requires several steps to ensure trustworthiness (Roberts et al., 2019). In this study,

we enhance trustworthiness by disclosing our researcher positionality and employing data triangulation methods, including thematic analysis and coding to consensus, to derive our findings. The first author is a STEM teacher educator and former secondary science teacher who has established both STEM and non-STEM SO at the secondary and college levels. She believes that students' experiences, both inside and outside of school, have important implications for their personal and academic success. The second author is a former secondary social studies teacher. Her research praxis centers on educational justice, and she believes that educators should interrogate systemic structures to better understand how they can equitably serve students. The third author is a former secondary mathematics teacher. Her research focuses on educator preparation and development, especially in STEM areas. We disclose our positionality as reflexive researchers who intentionally leverage subjectivity, acknowledging our roles in the research process to enhance the reliability and credibility of our findings (Probst, 2015).

RESULTS

Factors contributing to STEM PSTs' desire to join SOs

Our data revealed that STEM PSTs were strongly connected with their peers, followed by university staff and then faculty within the UTeachSA student organization (see Table 1).

Table 1: Participants' Connectedness to Peers, Faculty, and University Staff within the UTeachSA Student Organization

	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree
Peers	75%	14%	2%	2%	7%
Faculty	68%	20%	4%	4%	5%
University Staff	73%	18%	2%	2%	5%

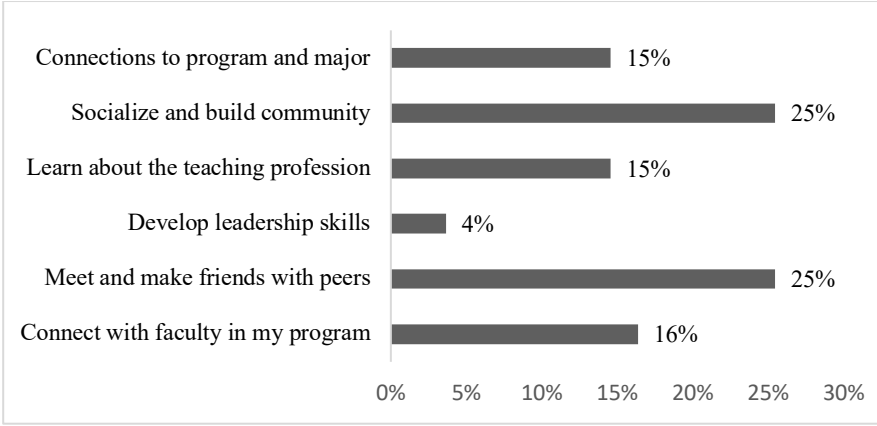
Note. n = 27. The percentages were rounded to the nearest whole number.

All twenty-seven PSTs responded to the following question: "*Rate your level of agreement with the following: As a result of participating in this activity, I feel more connected to peers, faculty, and university staff"*.

PSTs also responded to two open-ended response questions: "What encouraged you to participate in this activity?" and "What is one thing you gained from participating in this activity?". Our data revealed that the most

cited reason why STEM PSTs wanted to participate in an SO was to make friends and build communities (see Figure 1). Another top cited reason was their desire to also connect with faculty. These results indicate that interpersonal connections, formed through engaging with peers and faculty, were highly motivational factors in PSTs' decision to attend an SO activity. Twenty-three PSTs responded to the following question: "What encouraged you to participate in this activity?"

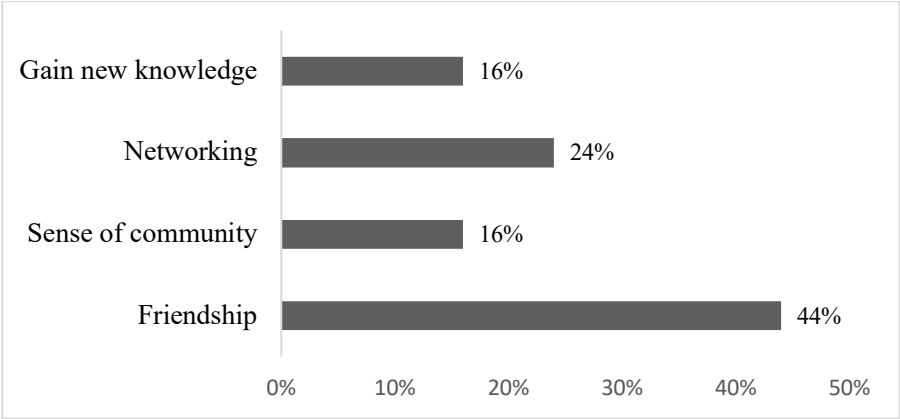
Figure 1: Factors influencing the participation of preservice STEM teachers in the student organization



Note. n = 23. The percentages were rounded to the nearest whole number.

We also found that PSTs reported "friendship" as a major takeaway from participating in an SO (44%) (see Figure 2). In addition, "networking" appeared in 24% of the responses, followed by "acquiring new knowledge" (such as knowledge of scholarship opportunities, academic knowledge, such as learning what courses to take, and knowledge of new skill sets, including public speaking and/or collaboration) and "sense of community," each of which appeared in 16% of the responses. Twenty-three PSTs responded to the following question: "What is the one thing you gained from participating in this activity?"

Figure 2: STEM Preservice Teachers' Perspectives on the Benefits of the Student Organization



Note. n = 23. The percentages were rounded to the nearest whole number.

Ways STEM SOs Support PSTs' Sense of Belonging

Our focus group data revealed four themes: networking, peer connections, informal mentoring, and leadership development.

Networking. Participation in the SO allowed PSTs to form partnerships with multiple stakeholders. PSTs shared that the SO was the first opportunity they had to engage with community partners outside of their class experiences.

> "Yeah, especially [STEM Day] community service event it was a lot of networking, even aside from working with the other teachers in the school district, some of the parents were part of the community as well….so to make different connections and networking in that way to connect with professors, or connect with other officers, was a good thing to do."

Peer Connections. Peer connections serve as a source of socioemotional support for PSTs. One PST shared:

> "It's for the sense of community…I mean, everybody wants to be a part of something, and when you're not a part of something it just gets really bad, you get stressed out and overloaded, but with the SO you know that you have a sense of community."

Another shared that the SO helped them reconnect with peers postpandemic:

> "Without the [SO], I wouldn't have had a community at UTSA when I started college it was one semester, then Covid started, and so I was not able to meet anybody except the people who were in my cohort. But, when the student org came back about, I was able to meet even more of my community."

Informal Mentoring. PSTs created a community of practice within the SO that allowed them to engage in informal learning related to academic content, university requirements, and practical skills transferable to their future teaching practices. For example, one PST described how they both received peer support and provided support to other PSTs in the following excerpt:

> "I got to meet many more people through this organization who were already doing their clinicals and helping out the freshmen coming up."

Participation in the SO also allowed PSTs to develop their lesson planning skills and learn new strategies for student engagement:

> "It allowed me to be more creative, coming up with like lesson plans and hearing from other people like how to get the kids involved and more engaged."

The SO also helped provide academic support, as students created collaborative groups to study for courses as well as state practices and state examinations:

> "I met some friends that were in some of my classes, and I was able to work with them and collab on homework, and I mean, we successfully passed our classes."

Leadership skills. PSTs shared how leadership roles within the SO helped them improve their confidence:

> "It definitely helped me build my confidence in speaking in groups."

Another stated that the leadership skills they learned helped them become strong team players:

> "It taught us … when to let other people's voices be heard before us, even though we're considered the like President, vice President, so on that we let other people shine as well."

In summary, these four themes reflect several key components of Kuttner's (2023) framework of belonging. For example, PSTs demonstrate agentic belonging, as they actively choose to engage with peers and community members for academic and professional support. Their sense of belonging is also place-based and not limited to a singular location. PSTs participated in community work and service activities that extended beyond the campus setting. This is important, as prior research has linked communication and interaction within student organizations with increased feelings of belonging (Reed et al., 2015). Additionally, leadership within the SO is characterized by a willingness to share rather than hoard power. PST leaders are learning to negotiate and distribute leadership roles collaboratively, which supports the development of personal agency and a collective sense of empowerment. Overall, the PSTs in the study described multiple interrelated aspects of belonging that were fostered through their participation in the SO.

DISCUSSION AND IMPLICATIONS

The findings from this study provide evidence that SOs increase students' sense of belonging by providing them with various forms of support, such as social-emotional support and a sense of community, which are also critical factors influencing students' persistence and rate of degree completion. SOs also help them grow as leaders, which lays the foundation for PSTs to become future teacher leaders in their schools. Our findings also suggest that when PSTs understand the value of developing a sense of belonging in their teacher preparation programs, they are more likely to carry these values of community building into their future teaching practices. This can help create inclusive classroom environments, foster strong relationships with students, and promote a collaborative school culture.

These findings have several implications for research and practice. Universities and teacher preparation programs aimed at supporting PSTs' needs through SOs should consider several factors. One important consideration is the creation of STEM-focused SOs that address the unique needs of specific affinity groups, particularly those with underrepresented racialized and gender backgrounds. These types of organizations support underrepresented groups in STEM fields by fostering a deeper sense of community and belonging (Espinosa, 2011; Rodriguez & Blaney, 2021). Increasing specificity in SOs broadens social capital by creating social networks among individuals who share similar identities and life experiences (Campbell-Montalvo, 2023; Gray & Shortlidge, 2025). For example, studies have shown that Latino and African American STEM majors are more likely to persist in their fields when they participate in STEM affinity groups (Espinosa, 2011; Rodriguez & Blaney, 2021). These groups offer

opportunities for marginalized students to connect in affirming ways, strengthening their sense of identity and community. Such efforts can ultimately contribute to diversifying the STEM teaching workforce, which remains predominantly White and female, with 80% of educators identifying as White women (National Center for Education Statistics, 2023). Future research on SOs should explore the intersectional identities of various underrepresented PST populations as well as the effects of SOs on students' sense of belonging and persistence in STEM education.

Another important implication in the development of SOs is faculty support and training. Faculty play a key role in both the formation and retention of SOs. Many universities require all SOs to have a faculty sponsor or advisor to ensure compliance with institutional policies (Dunkel et al, 2014). Therefore, faculty members benefit from professional development in terms of how to effectively support and initiate SOs on their campuses (Sanders O'Leary et al., 2020). Suppose the goal of SOs within a teacher preparation program is to foster students' sense of belonging among PSTs to the teacher profession. In that case, faculty training must include guidance on how to engage students in culturally relevant ways. Being a culturally relevant STEM faculty advisor goes beyond acknowledging diverse cultures; it requires a critical understanding of the sociocultural contexts that influence who persists and feels a sense of belonging in STEM (Ouedraogo-Thomas & Emenaha Miles, 2025; Sanders O'Leary et al., 2020). This critical perspective is essential for ensuring that SOs support all PTSs' sense of belonging in the STEM teaching profession.

CONCLUSION

Overall, our findings suggest that SOs provide multiple forms of support for increasing the sense of belonging among undergraduate STEM preservice teachers, including improving PSTs' socioemotional well-being, academic success, and connection to the teaching profession. Given the national shortage of science and math teachers, university and state leaders should continue to invest in SOs by allocating financial resources to sustain SO activities in teacher preparation programs, such as community outreach, social events, and professional development opportunities for students and faculty supporting the SOs to address teacher workforce needs, especially in shortage areas such as math and science. By building bridges between students, faculty, community partners, and the teaching profession, SOs can serve as a vital component in the recruitment and retention of STEM majors

in the teaching profession, helping to ensure that all students are taught by highly effective math and science teachers with strong STEM backgrounds.

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Bios

UCHENNA EMENAHA MILES, PhD, is an assistant professor at the University of Texas at San Antonio. Her research focuses on culturally responsive practices in STEM education, with an emphasis on equity, identity, and teacher preparation. Email: uchenna.miles@utsa.edu

SAMANTHA LEIHSING, M.A., is a graduate student at the University of Texas at San Antonio. Her research interests focus on anti-oppressive social studies teacher preparation and rehumanizing civic education. Email: Samantha.leihsing@utsa.edu

JANET SOLIS RODRIGUEZ, PhD, is an assistant professor at the University of Texas at San Antonio. Her research focuses on educator preparation and development, with a particular emphasis on educator quality, professional learning, and long-term outcomes. Email: janet.solisrodriguez@utsa.edu

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