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RESEARCH ARTICLE

Self-efficacy, agency, and values as predictors of STEM teacher leader identity in urban-like learning environments

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Abstract
Teacher leaders influence their peers by introducing innovative instructional methods and enhancing teaching quality. They have proven invaluable to school principals as they prioritize comprehensive teacher development, bolster teacher effectiveness, and promote teacher retention. Despite their importance, little to no research—prior to the present study—has shed light on the development of teacher leaders and the evolution of their leadership identity. While science, technology, engineering, and mathematics (STEM) teacher leaders offer a potential remedy for attrition in public schools, a substantial gap exists in understanding how a STEM teacher's self-efficacy, values, and agency contribute to their transformation into effective STEM teacher leaders, especially in urban-like learning environments. The present study focuses on STEM teacher leadership identity development and the challenges encountered. It ascertains the interplay between urban-like learning environments, self-efficacy, agency, the teacher leader's role within the school, and values in forecasting STEM teacher leadership identity. This research involved 100 in-service PreK-12 public school STEM teacher leaders. It yielded significant, positive, and meaningful relations between urban-like learning environments, self-efficacy/agency, teacher leader role, values, and STEM teacher leadership identity. These findings can enhance various facets of PreK-12 STEM education, including educational programming, teacher training, and cultivating STEM teacher leadership.

Over the past two decades, teacher leaders have influenced their peers by introducing new instructional practices and leading efforts to improve instruction (Derrington & Angelle, 2013). Teacher leadership has also become a valuable resource for principals as they prioritize school-wide teacher development, enhance teacher effectiveness, and support teacher retention. High teacher turnover rates are most prevalent in schools with high poverty rates, predominantly serving students of color, and a constant influx of new teachers. Simon and Johnson (2015) argue that

> teachers in schools serving high concentrations of low-income, low-achieving students of color are more likely to leave than their counterparts in other schools. When they leave, these teachers either exit the profession or transfer to schools with better

academic records and serve whiter, wealthier students (p. 3).

Various researchers have emphasized the urgent need for teacher leaders in urban schools. Wenner and Campbell's (2016) research suggests that "teacher leadership appears to be a potential solution to the issue of teacher attrition, as teachers can continue to teach while taking on additional leadership responsibilities" (p. 137). Offering experienced teachers the opportunity to develop new skills, embrace leadership roles, and support novice teachers could help slow down teacher attrition in high-needs schools, for both new and experienced teachers (Hutchinson et al., 2022). The teacher–leader role allows experienced teachers to lead without leaving the classroom and simultaneously serves as a strategy to reduce teacher attrition rates. However, how teacher leaders develop and how a leader's identity emerges must be better understood. Teacher leaders' emerging identities are still being researched in earnest ways. The process and mechanisms that foster teacher–leader identity development are now a primary focus in teacher leadership research (Barth et al., 2023; Yow et al., 2021). Furthermore, there is a palpable gap in research regarding the specific need for teacher leaders in urban-like learning environments. According to Milner (2012), urban environments present various challenges external to the school staff, such as high truancy rates, poverty, a lack of parental involvement, academic struggles, student motivation issues, and behavior problems. However, there is a lack of knowledge about developing teacher leaders who are prepared to work in urban-like learning environments.

For the present study, we defined urban-like learning environments by demographics and the social contexts in which teaching and learning occur. The schools with the greatest needs are often found in urban-like learning environments and frequently face severe issues that negatively impact the quality of science, technology, engineering, and mathematics (STEM) teaching and learning. These schools typically have a high enrollment of minority students and/or a significant concentration of students living in poverty, as well as the characteristics defined by Milner (2012) above. Moreover, high-needs schools tend to have a disproportionately higher number of novice teachers compared to non-high-needs schools. Carver-Thomas and Darling-Hammond (2017) state that teacher turnover rates in Title 1 schools are 50% higher (16% compared to 11% in non-Title 1 schools), while turnover rates are 70% higher in schools serving students of color (over 55%) compared to schools with the fewest students of color (less than 10%). As teacher attrition rates increase, they harm student achievement and school improvement efforts, especially in high-needs schools (Lyons, 2022). The role of a STEM teacher leader emerges as a potential solution to address teacher attrition in the STEM field. Teacher leaders have become one way to tackle public schools' attrition challenges. Teacher leadership has emerged as a potential strategy for principals to engage teachers in career development, address school improvement needs, and support teacher retention. However, the extant literature does not comprehensively explore how a STEM teacher's self-efficacy, values, and agency contribute to their development as a STEM teacher leader in urban-like STEM learning environments.

1 | CONCEPTUAL FRAMEWORK

1.1 | STEM teacher self-efficacy

Bandura (1994) defined perceived self-efficacy as individuals' beliefs in their ability to achieve desired performance levels and exert control over events that impact their lives. Self-efficacy influences emotions, thoughts, processes, and behaviors. Self-efficacy refers to teachers' confidence in their ability to positively influence student learning through their individual and collective capabilities (Klassen et al., 2010). Therefore, teachers' self-efficacy influences their teaching efforts, instructional goals, and professional and personal aspirations (Tschannen-Moran & Hoy, 2001).

Importantly, self-efficacy is not a fixed trait but situational (Bandura, 1977). A teacher's self-efficacy may vary in different school or classroom settings. Urban-like learning environments often serve students facing significant poverty, diversity, and equity challenges. In these STEM learning environments, teachers encounter obstacles unique to urban-like settings. Additionally, STEM instruction can vary across contexts due to integration practices, attitudes, materials, resources, and safety concerns (Wenner, 2017). Therefore, when considering STEM teacher leadership and self-efficacy, it is crucial to recognize the distinctiveness resulting from these specific challenges.

1.2 | STEM teacher agency

Bandura (2001) stated that being an agent involves intentionally taking action to make things happen. Agency encompasses critical aspects such as intentionality, forethought, self-reactiveness, and self-reflectiveness, enabling individuals to participate in self-development actively, adapt to changing circumstances, and promote self-renewal (p. 2). In the context of STEM teachers, achieving agency within a school setting involves utilizing their self-awareness and understanding of the school culture to address instructional and academic challenges, drive change, and navigate hierarchical systems, complex relationships, and established processes and structures (Balgopal, 2020; Priestley et al., 2016). By exercising agency, STEM teachers can actively shape their identity and professional growth and contribute to improving their teaching practice and the school as a whole.

1.3 | STEM teacher identity

Identity theory identifies and explains role-related behaviors, their relationship to a social structure, and an individual's self-perception within those roles (Hogg et al., 1995). According to Stets and Burke (2000), identity theory posits that the self can be responsive to its environment's social structure and categorize or classify itself in a particular role based on that social construct, which defines the identity. Teachers within school structures have a well-defined role, purpose, and identity rooted in a specific identification category based on their organizational hierarchy. Also, as individuals engage within a social structure, they align themselves to help shape their identity.

Social identity theory is centered around membership in a group. One's social identity is determined by a group affiliation in which a social identification drives the members. Stets and Burke (2000) state that "people derive their identity or sense of self largely from the social categories to which they belong" (p. 225). Social identity depends on roles and categories that contextual situations or expectations can shape. Exposing teachers to new skills, practices, and the potential of new categorization can shift that role identity from teacher to leader within the school construct (Knapp, 2017).

Opportunities for lived experiences in which teachers can learn and practice new skills associated with their new roles are essential to developing identity. A STEM teacher leader identity is created within a school's social construct in which the teacher enacts a dual identity, that of a teacher and a leader. Leader identity development is essential to teachers' ability to enact STEM teacher leadership.

1.4 | STEM teacher values

Values are what we, as people, think of as essential in life. The Schwartz Theory of Basic Values (Schwartz, 2012) has six main characteristics: (a) values are beliefs, (b) values refer to desirable goals, (c) values transcend specific actions and situations, (d) values serve as standards or criteria, (e) values are ordered by importance, and (f) the relative importance of multiple values guides action.

The theory identifies 10 universally observed values across cultures, with little or no variation: Achievement, Benevolence, Conformity, Hedonism, Power, Security, Self-Direction, Stimulation, Tradition, and Universalism. These 10 values then fit "a total pattern of relations of conflict and congruity among values" (Schwartz, 2012, p. 8). Table 1 provides definitions for all 10 values.

The conflict between values arises from the opposing relation category themes they represent. A relation category theme groups similar values together. Opposing relation categories present conflicts with values. For example, the conflict between the Openness to Change and Conservation relation categories involves values associated with independence of thought and action versus order, preservation of the past, and resistance to change (Schwartz, 2012). Similarly, the conflict between Self-Transcendence and Self-Enhancement relation categories reflects the tension between the concern for others' welfare and the pursuit of one's interests and dominance over others (Schwartz, 2012).

Bardi and Schwartz (2003) found that individuals express their values through their behaviors, and most people can identify and describe their values. Values naturally motivate and guide actions, as people tend to behave in ways that express or promote their important values (Bardi & Schwartz, 2003). Understanding how values promote teacher agency can contribute to creating a more engaged school climate (Hadar & Benish-Weisman, 2018).

In the context of teacher leadership, specific values align with the criteria for innovation and creativity, reflecting the Openness to Change dimension (including values of stimulation and self-direction). Conflicts can arise between values such as achievement and benevolence, where achievement focuses on subject-matter expertise, while benevolence emphasizes considering the whole. Values of conformity, tradition, and security within the Conservation dimension are often excluded due to conflicts with Openness and their tendency to maintain the status quo rather than drive transformation. Power and universalism are also excluded due to conflicts and negative associations with teacher leadership (Schwartz, 2012).

In 2012, Schwartz et al. refined the Theory of Basic Values, subdividing the original 10 values into 19 values. However, incorporating these additional values into the research instrument would increase response time and potentially decrease data reliability.

TABLE 1 Definitions of the 10 values identified by Schwartz et al. (2012).

Relation category themes	Value	Inclusion in survey	Conceptual definition
Conservation	Conformity	No	Restraint of actions, inclinations, and impulses likely to upset or harm others and violate social expectations or norms
Conservation	Security	No	Safety, harmony, and stability of society, relationships, and self
Conservation	Tradition	No	Respect, commitment, and acceptance of the customs and ideas that one's culture or religion provides
Openness to change	Self-direction	Yes	Independent thought and action–choosing, creating, and exploring.
Openness to change	Stimulation	Yes	Excitement, novelty, and challenge in life.
Openness to change self-enhancement	Hedonism	No	Pleasure or sensuous gratification for oneself
Self-enhancement	Achievement	Yes	Personal success through demonstrating competence according to social standards
Self-enhancement	Power	No	Social status and prestige, control, or dominance over people and resources
Self-transcendence	Benevolence	Yes	Preserving and enhancing the welfare of those with whom one is in frequent personal contact (the "in-group")
Self-transcendence	Universalism	No	Understanding, appreciation, tolerance, and protection for the welfare of all people and for nature

1.5 | STEM teacher leadership

In the extant literature, various definitions of teacher leadership can be applied to studying a STEM teacher's development as a leader. For example, the definition by York-Barr and Duke (2004), which states that teacher leadership is "the process by which teachers, individually or collectively, influence their colleagues, principals, and other members of the school community to improve teaching and learning practices with the aim of increased student learning and achievement" (pp. 287–288), is very comprehensive. This definition suggests that STEM teacher leadership is crucial in promoting student achievement in STEM subjects, improving STEM curricula, and driving overall change and improvement in the field (Velasco et al., 2021). However, the research team felt that the definition of teacher leadership is best described using Criswell et al. (2018). Their three-part definition defines how an individual gains a deep understanding of their educational practice concerning the system, develops a vision for innovation that impacts the system, and, with this vision, can empower others to promote change within the system.

For the present study, a formal teacher leader holds an assigned role or position within the school's management team. Examples of such positions include coach, mentor, specialist, grade-level chair, content/department chair, or member of task forces. On the other hand, an informal teacher leader is someone whose primary role lies within the classroom. However, they exert leadership influence among their peers through their expertise, collaboration, and innovative instructional practices.

1.6 | Analysis of the challenges STEM teacher leaders face by the Ecological Systems Theory

Bronfenbrenner (1977) developed the Ecological Systems Theory (EST), which proposes that multiple hierarchical layers or structures influence a child's development. The innermost layer is the Microsystem, which includes the immediate environment that directly interacts with the child. The second layer is the Mesosystem, which encompasses the interactions between different microsystems. The middle layer is the Exosystem, incorporating social structures that indirectly influence the child. The fourth layer is the Macrosystem, focusing on cultural elements that impact the child's development. The final layer is the Chronosystem, which considers the environmental changes occurring throughout the child's lifetime and their impact on development.

EST has been applied to various educational contexts. For example, Zavelevsky and Lishchinsky (2020) applied EST to innovative approaches to retaining novice teachers. In our work with teacher leaders, we have also applied EST: The teacher leader is positioned at the center of the model, surrounded by the first layer, the Microsystem, which includes their classroom or designated space and direct interactions with colleagues at school. For example, Kasapoğlu and Karaca (2021) found that

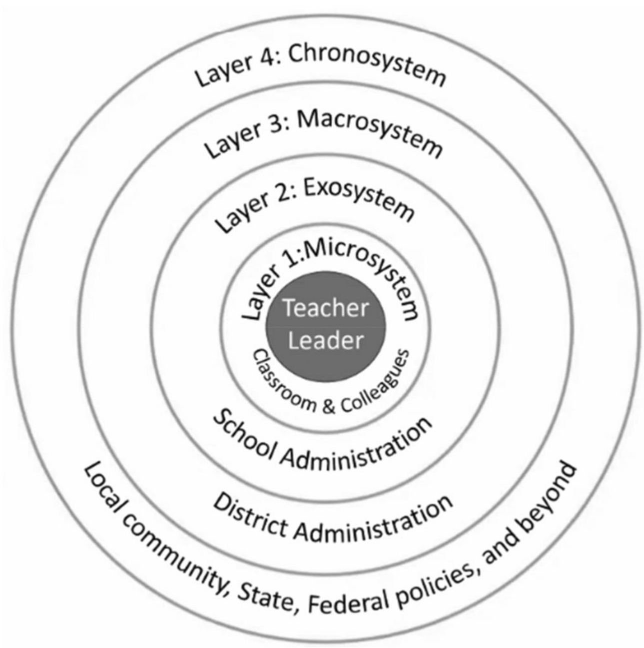

FIGURE 1 Application of Ecological Systems Theory to our research.

teacher leaders identified crowded class size as an obstacle, and this challenge would reside in the first layer. The second layer is the Mesosystem, which encompasses the relationships between the teacher leader and their students and interactions with colleagues in various group settings, excluding administrative interactions. If teacher leaders feel that their colleagues are not sufficiently idealistic, as Kasapoğlu and Karaca (2021) found, then this would be classified under the Mesosystem. The middle layer, the Exosystem, involves interactions with school administration and the school as an entity. A sample challenge could be that teacher leaders perceive that their school administrators are hindering critical thinking (Kasapoğlu & Karaca, 2021). The second outermost layer, the Macrosystem, includes the impact of district-level administrative decisions, policies, procedures, communications, and the school community. Lastly, the Chronosystem relates to contextual factors beyond the district's control that influence the teacher leader, such as state or federal policies that can either support or hinder their efforts. Figure 1 illustrates the application of the Ecological Systems Theory to our work.

1.7 | The present study

We developed two distinct but connected research questions:

- Research question one: What are the relations between urban-like learning environments, self-efficacy, and agency, the role of a teacher leader within the school, and values in predicting STEM teacher leadership identity?
- Research question two: What are STEM teacher leaders' challenges directly related to their role?

To test the relations identified in the research question, we developed a hypothetical model where identity relates directly to self-efficacy, agency, role, value, and leadership. We analyzed respondents' responses to the open-ended question and categorized the challenges identified through the lens of the EST. The two research questions are related because people's beliefs about their self-efficacy can influence their situations and perceived challenges (Bandura, 1977).

This study adds to the extant literature on STEM teacher leadership. Understanding possible factors related to and the challenges faced while developing a STEM teacher leader identity can inform the design of support systems for improving STEM instruction.

2 | METHODS

2.1 | Participants

The following criteria were established to identify this study's sample frame of STEM teachers in one state of the United States. First, the teachers had to be employed by one of the state's Local Education Agencies (LEAs), work as classroom-based teachers in public or charter schools, and teach at least one STEM content/subject area. STEM content/subject areas are defined as courses that are aligned with any of the following standards: Computer Science Teachers Association (CSTA) K-12 Computer Science Standards, International Society for Technology in Education (ISTE) Standards, Common Core State Standards for Mathematics, Next Generation Science Standards (NGSS), and Standards for Technological and Engineering Literacy (STEL).

Additional inclusionary criteria were explored, including factors like being a teacher leader, the teacher of record, instructional time, areas of licensure, and work location. The teacher of record criterion was excluded because it would overlook teachers of students with disabilities and those teaching Multilingual Learners (MLs) who may possess STEM backgrounds and serve as teacher leaders in their schools. Areas of licensure were excluded as the state's Department of Education issues conditional teaching licenses nonspecific to content areas. Some STEM teacher leaders may hold conditional licenses, which would not be included in the study. Work location was an exclusionary criterion to focus solely on school-based STEM teacher leaders.

TABLE 2 Background information of survey respondents.

Background information	Teacher leadership roles							
	Formal ($n = 48$)				Informal ($n = 52$)			
	n	%	*M*	SD	*n*	%	*M*	SD
Race/ethnicity								
Asian	5	10.42			2	3.85		
Black/African-American	14	29.17			16	30.77		
Hispanic	2	4.17			0	0.00		
White	27	56.25			34	65.38		
Grade level taught								
Elementary (PreK-5)	24	50.00			25	48.08		
Middle (6–8)	13	27.08			12	23.08		
High (9–12)	10	20.83			12	23.08		
Elementary and middle (PreK-8)	0	0.00			2	3.85		
Secondary (6–12)	0	0.00			1	1.92		
All levels (PreK-12)	1	2.08			0	0.00		
STEM subjects taught								
Engineering	1	2.08			1	1.92		
Engineering and technology	3	6.25			2	3.85		
Maths	16	33.33			21	40.38		
Maths and science	12	25.00			20	38.46		
Maths, science, and technology	2	4.17			1	1.92		
Science	9	18.75			7	13.46		
Technology	2	4.17			0	0.00		
None	3	6.25			0	0.00		
Urban-like learning environments								
School only	4	8.33			3	5.77		
District only	3	6.25			9	17.31		
Both	39	81.25			33	63.46		
Neither	2	4.17			7	13.46		
Total years teaching								
<3	4	8.33	15.78	8.14	9	17.31	9.13	8.75
4–9	10	20.83			24	46.15		
10–14	6	12.50			7	13.46		
15 or more	27	56.25			12	23.08		
Total years teaching STEM								
<3	11	22.92	13.74	7.88	11	21.15	9.09	8.37
4–9	11	22.92			23	44.23		
10–14	6	12.50			7	13.46		
15 or more	25	52.08			11	21.15		

The survey respondents ($N = 100$) were in-service PreK-12 public school STEM teacher leaders in the Middle Atlantic United States. All respondents taught mathematics, science, technology, or a combination of these subjects. The grade levels of the respondents varied, with 49 teaching in elementary settings (grades PreK-5), 25 in middle school settings (grades 6–8), 22 in high school settings (grades 9–12), 1 in a combined elementary/middle school setting (PreK-8), and 1 in a combined middle/high school setting (grades 6–12). On average, the respondents had 12.73 years of teaching experience ($SD = 8.92$), while their average teaching experience in STEM subjects was 11.32 years ($SD = 8.43$). Table 2 summarizes the respondents' teaching backgrounds based on their teacher leadership roles.

2.2 | Instrument

The researchers wanted all respondents to self-identify whether their school and/or district were urban-like by indicating if their school and district met the criteria in the question "We define an 'urban-like learning environment' as an environment that has one or more of the following that are external to the school staff: (a) high minority enrollments or, (b) high concentrations of students living in poverty, (c) truancy concerns, (d) lack of parental involvement, (e) academic challenges, (f) lack of motivation among students, (g) behavior problems. Do you consider the (school or district) that you work in to fit this description?" Additionally, respondents also had to self-identify if they were teacher leaders by answering the following question: "We define a teacher leader as someone who actively engages in improving teaching and learning and may individually or collectively influence their colleagues, principal, and other school community members to enhance teaching and learning practices that impact overall school improvement. Do you consider yourself to be a STEM teacher leader?" If respondents answered "yes," they were asked to self-identify if they were formal or informal teacher leaders. All self-identifying questions provided definitions to base their responses. This allowed us to determine inclusionary criteria (urban-like learning environment and being a teacher leader) and validate the extent of the influence of the urban-like learning environment on STEM teacher leadership.

We adapted and modified items from various sources to develop the survey instrument. Specifically, for self-efficacy, items were derived from Riggs and Knochs' Science Teaching Self-Efficacy Beliefs Instrument (STEBI) (Riggs & Knochs, 1990). For example, "I am continually finding better ways to teach STEM." For STEM teacher agency, items were adapted from the learning and teaching effectiveness instrument developed by Liu et al. (2016). For example, "If one of my students can't do a class assignment, I am able to accurately assess whether the assignment was at the correct level of difficulty." Based on consultation with experts in STEM education, teacher leadership, and educational psychology, the research team felt that 4 of the 10 values that Schwartz et al. (2012) identified aligned with teacher leadership qualities. Those four values are achievement, benevolence, self-direction, and stimulation, and items related to these values were taken from the Portrait Values Questionnaire (Schwartz et al., 2001). For example, "It is important to the STEM teacher to make their own decisions about what they do. The STEM teacher likes to be free to plan and to choose their activities for themself." Additionally, items focusing on STEM teacher leadership through the lens of instructional leadership were derived from Xie et al. (2020). For example, "I assist colleagues in designing appropriate teaching strategies for varied students."

All of the Likert-style statements in the survey were presented to participants using a slider, requiring them to move it along a continuum to indicate their responses. The response scale for the Teacher Self-Efficacy, Teacher Agency, and Teacher Leadership constructs ranged from "Strongly Disagree" to "Strongly Agree." For the Teacher Values construct, the scale ranged from "Does not look a lot like me" to "Looks very much like me." The scale ranged from 0 to 5, and responses were recorded to the nearest 0.01 increment.

We conducted a readability test of the instrument using Microsoft Word's built-in Flesch–Kincaid grade-level analytics. The estimated grade reading level of the entire survey was 9.2, indicating that it was written in a way that students in the ninth grade would likely understand. Therefore, with all participants being in-service teachers and having completed their bachelor's degrees, we evaluated the readability as satisfactory.

2.3 | Instrument validity, reliability, and pilot study

Throughout the process, content-specific terms were replaced with "STEM" or more general phrases to ensure relevance to the study's context. We evaluated the face validity of the newly constructed items based on their similarity to existing items in well-validated measures. We also evaluated the face validity of the surveys based on consultation with experts in STEM education, teacher leadership, and educational psychology. These experts provided feedback which helped us to evaluate the surveys' content validity. Based on the experts' feedback and subsequent revisions to the items, we evaluated the overall construct validity (via face and construct validity) as satisfactory. Furthermore, we evaluated the inter-item reliability based on consistency between items in the survey, with McDonald's ω equal to 0.827, indicating satisfactory reliability.

We conducted a pilot test using in-service teachers currently enrolled as graduate students at one university.

Leonard et al. (2023) reported the results of this sample frame and included it in the dataset used for analysis. We revised two demographic questions due to input from participants during the pilot study. One question initially only listed grades 1–12, but participants also taught in pre-kindergarten and kindergarten. The revised question includes all grades from pre-kindergarten through 12th grade. During the pilot study, some participants with primary roles within the classroom did not self-identify as teacher leaders because they did not have an assigned role within their school's management team. The revised teacher leadership questions provide a more robust definition of teacher leadership and the formal and informal teacher roles.

2.4 | Procedures

While recruiting teacher participants, we made a series of ethical considerations to receive permission for surveying within the identified sample frame. Before the survey was disseminated, we obtained Institutional Review Board (IRB) approval from our affiliated institutions. Purposive sampling was used to gather responses from the sample frame. We emailed teachers participating in STEM or mathematics education graduate programs at our affiliated institutions. The email included an introduction to the research and a link to the Qualtrics survey. Additionally, we obtained approval from the relevant districts before administering the survey to adhere to each school district's policies and procedures regarding external research requests. As members of several professional teaching organizations with state chapters, we facilitated survey dissemination through these organizations, thereby reaching a wider audience of teachers.

3 | ANALYSES AND RESULTS

3.1 | Data preparation and cleaning

We downloaded data from Qualtrics twice a week, imported these data into a Microsoft Excel workbook for cleaning and analysis, and used the following procedure to clean the data:

1. Unique code generation: Respondents were assigned a unique code based on their responses to six specific questions.
2. Grade level and subject categorization: Respondents' grade levels were categorized into five buckets and respondents' courses were placed into buckets based on subject areas.
3. Teacher leadership categorization: Respondents identified as not being teacher leaders were excluded from the analysis.
4. Teacher role categorization: Based on respondents' answers to two questions, the role of teacher leader was classified as either “formal” or “informal.”
5. Reverse scoring: Questions relating to values were scored according to Schwartz et al. (2001).
6. Variable score calculation: Responses for self-efficacy, agency, and teacher leadership were averaged to obtain variable scores for these constructs.
7. Values sub-score calculation: Sub-scores were calculated by averaging responses for achievement, benevolence, self-determination, and stimulation.
8. Average values calculation: An overall average was calculated for the values construct.

Using these cleaning procedures, we organized and analyzed the data effectively to maintain an accurate alignment between variables and sub-scores with the studied constructs (i.e., to ensure construct validity).

3.2 | Quantitative analysis and results

To analyze the relationships in the hypothetical model, we used Partial Least Squares Structural Equation Modeling (PLS-SEM), which allowed us to model the relationships between variables and test outcome predictions that reflect the complexity of real life. SEM can account for observed respondent characteristics and help reduce bias from non-random sampling by modeling relationships and controlling for key variables. In our analysis, we constructed latent variables based on the observed survey sub-scores of respondents' schools and districts' urban identity, self-efficacy/agency, role (formal, informal, and not), and values (achievement, benevolence, self-direction, and stimulation). These latent variables are represented in Figure 2 of the model. We used WarpPLS 8.0 software (Kock, 2022), which employs a “warping” partial least squares (PLS) path analysis approach and potentially increases accuracy and statistical power by applying non-parametric methods in studies with relatively small sample sizes (Reinartz et al., 2009), such as the present study. Using WarpPLS 8.0, we aimed to investigate the hypothesized relations between the identified latent variables and gain insights into the model's dynamics and interactions.

The Tenenhaus Goodness of Fit (GoF) value was 0.321, indicating a medium effect size. However, the average relational path R^2 value was 0.117, $p = 0.06$, indicating a relatively low effect size when looking at all the paths overall. In examining these somewhat

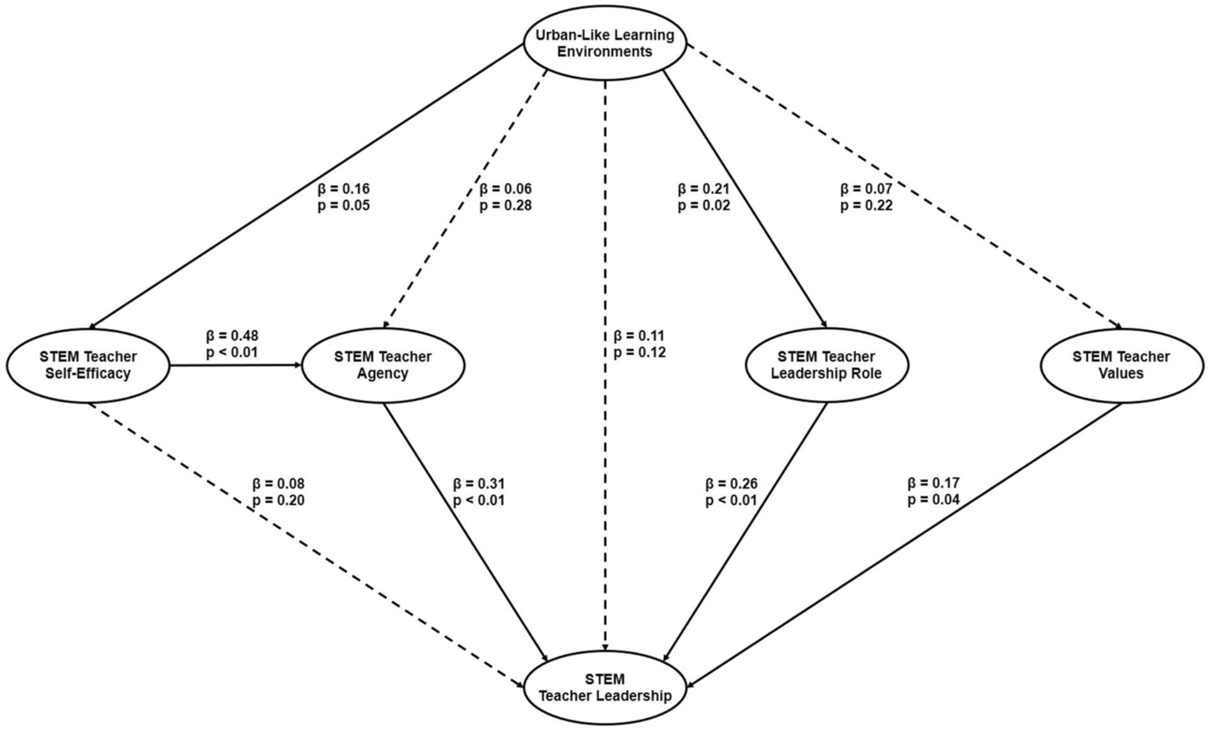

FIGURE 2 Path model showing relations between study variables. Solid line arrows show significant relations between variables, with standardized path and *p*-values as labels. Dotted line arrows show nonsignificant relations.

contradictory model robustness indices, we evaluated the model quality to be satisfactory because most of the beta weights (standardized path values) revealed positive and significant direct relationships between urban-like learning environments and self-efficacy/agency, as well as between self-efficacy/agency, STEM teacher leadership role, values, and STEM teacher leadership, with medium effect sizes, supporting our overall hypothesis.

In our model, value scores were calculated as the average score for each respondent. However, since values are ordered by importance relative to each other (Schwartz, 2012), teacher leaders may have had some patterns in their prioritization of values. To explore this further, we determined the value for which each respondent had the highest score. The results showed that 8% of respondents had achievement as their highest value, 40% had benevolence, 30% had self-direction, and 8% had stimulation. Some respondents had ties between their top two values: Achievement/Benevolence (2%), Achievement/Self-Direction (1%), Benevolence/Self-Direction (7%), and Self-Direction/Stimulation (1%). Additionally, 2% of respondents indicated all four values. Notably, there is a conflict between achievement and benevolence values, as pursuing personal success may hinder actions to enhance the welfare of others in need (Schwartz, 2003).

Our quantitative analysis revealed that teachers' perceptions of their learning environment account for approximately 2% of the variation in self-efficacy. Additionally, their perceptions of the learning environment and self-efficacy explain ∼23% of the variation in STEM teacher agency. This underscores the critical role of how STEM teachers perceive their learning environment in shaping their self-efficacy and agency.

Furthermore, as follow-up analyses and to provide additional explanations of the structural equation modeling results, we conducted *t*-tests to gauge whether differences existed in the responses between STEM teachers with a formal leadership role and those with an informal leadership role. The results in Table 3 indicated that STEM teachers with a formal leadership role had higher scores on the teacher leadership construct ($M = 3.60$, $SD = 1.11$) than STEM teachers with an informal leadership role ($M = 2.80$, $SD = 1.17$, $t(\text{df}) = 97.87$, $p = <0.001$, Cohen's $d = 0.7$), indicating a moderate to large effect size. However, there were no significant differences in the scores for self-efficacy, agency, and values constructs between the two groups.

3.3 | Qualitative analysis and results

We used an open-ended question to investigate our second research question, focusing on STEM teacher leaders' challenges. The question, "Please describe any challenges

TABLE 3 Comparison of formal versus informal teacher leadership results.

	Teacher leadership						
	Formal role		Informal role				
Latent variables	*M*	*SD*	*M*	*SD*	*t* (df)	*p* value	Cohen's *d*
Self-efficacy	3.89	0.78	3.84	0.73	96.13	0.780	0.056
Agency	3.98	0.66	3.88	0.56	92.14	0.459	0.150
Achievement	2.53	1.34	2.62	1.31	97.03	0.728	−0.070
Benevolence	3.75	0.87	3.61	0.89	97.73	0.409	0.166
Self-direction	3.69	0.76	3.45	0.81	97.98	0.130	−0.091
Stimulation	2.92	1.14	3.08	1.00	93.88	0.468	−0.147
Values	3.24	0.80	3.20	0.81	97.63	0.774	0.058
Teacher leadership	3.60	1.11	2.80	1.17	97.87	<0.001	0.705

TABLE 4 Challenges of STEM teacher leaders categorized by Ecological Systems Theory (EST) layer.

EST layer	Challenges of teacher leaders (TLs)[a]	Example response	*f*
0	*Teachers lack interest in developing/sustaining skills	"When asked to try something new…, there is pushback."	8
0	Teacher leader feels they need better understanding of STEM concepts	"not being able to describe the why behind a … method for solving a problem…"	9
0	Individual capacity: Teacher leader feels leadership aspect of workload too high	"It would be better to be out of the classroom…to better assist colleagues."	2
1	*Teacher leaders' initiatives may be blocked by their colleagues	"Other departments wanting to utilize our space for their 'more important' projects."	9
1	Students' attitudes towards STEM	"Students not wanting to engage in productive struggle."	7
2 & 3	*Insufficient time to carry out or plan lessons	"Having adequate planning time to plan creative and engaging activities …"	29
2 & 3	*Insufficient materials/supplies or funding for supplies	"Most teachers rely on their personal money in purchasing their instructional needs."	22
2 & 3	*Administrators prevent Teacher leaders' initiatives from taking place	"Lack of administrative support, lack of trust by administrators…"	5
2 & 3	*The current system and policies prevent teacher leaders from using their creativity and imagination	"There is very, very little time …for teachers …to collaborate or even communicate."	9
2 & 3	Insufficient time for or quality of professional learning experiences	"The expectation that teachers … engage in professional development on their own time."	5
3 & 4	*Legislation and curriculum: district-mandated curriculum does not meet the needs of students	"Our math curriculum [does not] to support various levels of student understanding."	23
4	*Crowded classes	"Class size is too large. I teach 30 students."	1
4	*The teacher is viewed critically by parents, students, etc.	"Parents unsure of newer teaching practices."	1
4	Supply chain and shipping issues	"Supply chain and shipping issues that made it challenging to teach…"	1
1 & 4	*Colleagues: TLs' colleagues inadequately educated	"Some teachers don't understand the math concepts behind the lesson."	1

[a]* indicates that the code was also observed by Kasapoğlu and Karaca (2021).

you faced that are directly related to your role as a STEM teacher leader," asked survey respondents to describe any challenges they encountered directly related to their role as STEM teacher leaders.

All of the respondents' responses were examined. Some responses indicated more than one issue or sub-issue; in this case, each issue/sub-issue was coded separately. If the response was blank or contained a variation of "N/A," the response was not coded. The team used protocol coding in the first coding cycle (Saldaña, 2021), which is appropriate for studies with pre-established and field-tested coding systems. The team began with the codes that Kasapoğlu and Karaca (2021) found as obstacles to becoming a teacher leader. Then, the team added six additional codes, as revealed by the respondents.

For alignment of the codes, coding was done manually with all five co-authors for 20% of the responses to ensure reliability. The remaining 80% of the responses were coded by two co-authors manually and separately at first; then, the two co-authors compared their codes and agreed when there were discrepancies.

In the second coding cycle, we employed pattern coding (Saldaña, 2021), where category labels are assigned to similarly coded data. To examine the themes of the identified codes, we applied Bronfenbrenner's (1977) Ecological Systems Theory (EST) to categorize and classify the codes into different layers of influence. Table 4 summarizes the challenges, their corresponding layers, sample responses, and the frequency of responses for each code. Layer 0 refers to the individual teacher leader's capacity and beliefs. Layer 1, the Microsystem, refers to challenges related to colleagues or students in the teacher leader's classroom. Layer 2, the Exosystem, refers to challenges associated with school administration decisions, such as the amount of planning time allocated within the school day or administrators preventing teacher leaders' initiatives from being implemented. Layer 3, the Macrosystem, refers to the school district administration challenges, such as curriculum selection or time allocated for professional learning experiences. Layer 4, the Chronosystem, refers to the local community's challenges. Most identified challenges were within Layers 2 and 3, indicating a perception of a lack of administrative support for initiatives, insufficient planning time and materials, and dissatisfaction with the scripted curriculum decisions in one of the LEAs.

4 | DISCUSSION AND IMPLICATIONS

Our study supports the hypothesis that self-efficacy, agency, and values are strong indicators to predict a STEM teacher's emerging teacher leader identity and development as a teacher leader in urban-like learning environments. Furthermore, our study revealed that teachers' perceptions of their learning environment shape their self-efficacy and agency, which limit their role and ability as a STEM teacher leader. The findings from this study can inform educational leaders at the LEA and teacher-leader development programs at the college and university levels. Teacher leadership plays a significant role in promoting student learning, as teacher leaders are well-positioned to drive positive change within their schools (Wenner & Campbell, 2016).

This study's findings can contribute to improvements in various areas of STEM education, particularly within the PreK-12 environment, STEM education programs, STEM teacher training, and STEM teacher leadership development. Designing and implementing cutting-edge methods for STEM teacher leaders' professional learning experiences can inform these improvements. As a result, a framework for standards focusing on teacher leadership in STEM education needs to be developed, as no such framework currently exists. By considering these findings and implementing the necessary frameworks and standards, stakeholders in STEM education can enhance the professional development and support provided to STEM teacher leaders, ultimately improving the quality of STEM education for students.

To increase the generalizability of this work, it would be beneficial to broaden the geographic representation of the respondents and increase the survey response rate. Additionally, it is recommended that all 19 values within the Schwartz Value Theory be incorporated and that the Portrait Values Questionnaire-Revised (PVQ-RR) developed by Schwartz (2017) be utilized to provide a more comprehensive and detailed assessment of the 19 new values. This would allow for a deeper understanding of STEM teacher values and STEM teacher leader identity development.

Another area of investigation could be exploring how a STEM teacher leader's race and ethnicity contribute to their self-efficacy, agency, values, and overall teacher leadership in an urban-like learning environment. Research by Fuller and Pendola (2019) suggests that personal characteristics, including race and ethnicity, can impact teacher retention and turnover. Understanding the influence of these factors on STEM teacher leaders' experiences and perspectives would provide valuable insights into promoting diversity, equity, and inclusion within STEM teacher leadership.

Furthermore, designing and implementing an intervention to enhance self-efficacy, agency, and values would be beneficial, thereby strengthening teacher leadership capacity. The instrument developed in this study could serve as a baseline assessment to capture pre-intervention data. STEM teacher leaders would then participate in targeted professional development activities as part of the intervention. Finally, the instrument could be administered again as a post-survey to measure any participant score changes after the intervention. Assessing the effectiveness of such interventions in enhancing teacher leaders' capacities would contribute to the literature on STEM teacher leadership development and inform best practices in professional development programs.

Pursuing these avenues of future research can further deepen our understanding of STEM teacher leadership, values, and the factors contributing to their development and effectiveness. This knowledge can inform evidence-based strategies and interventions to support and empower STEM teacher leaders, ultimately benefiting teachers and students.

This research has important implications for policy development at the state and federal levels. At the federal level, these findings can contribute to developing national STEM teacher leadership standards, which can be modeled after the National Education Association's Teacher Leader Standards. These standards provide a framework for guiding the professional development and recognition of STEM teacher leaders nationwide.

One significant insight from the research is the need to address teacher capacity at the pre-service level. Teachers' lack of foundational content skills suggests a potential gap in their initial training and preparation. To explore this issue further, it would be valuable to investigate the backgrounds and pathways to initial licensure of the respondents in the study, considering both traditional and non-traditional routes. This information can inform policy discussions on teacher education programs and highlight the importance of equipping teachers with the necessary content knowledge in STEM subjects.

Additionally, this research highlights the challenges STEM teacher leaders face regarding content knowledge. These challenges affect professional development efforts, as STEM teacher leaders may need support in enhancing their basic content knowledge. Consequently, there is a need for policy changes, such as revising state credentialing requirements to address STEM coursework requirements for initial licensure in elementary and early childhood education. By ensuring a balanced distribution of credits or content knowledge in STEM subjects, these changes can better prepare teachers in these fields and alleviate the challenges STEM teacher leaders face.

Advocating for national STEM teacher leadership standards and addressing content knowledge requirements in teacher preparation programs through policy changes can improve the quality of STEM education and support the development of influential STEM teacher leaders. These policy implications have the potential to positively impact the education system by strengthening teacher capacity and promoting the integration of STEM practices and principles in classrooms. This study also supports the need for advocates to include STEM teacher leaders in policy actions (Hite et al., 2020), as STEM teacher leaders are well informed of current issues they and their colleagues face.

Due to the various professional partnerships created through this project, our team members have received funding for a research project focusing on STEM teacher leadership. This project is a collaborative effort between two Mid-Atlantic urban research universities. It aims to improve STEM teachers' instructional practices and build capacity for STEM teacher leadership through a professional learning community that uses makerspace technology and justice-centered STEM pedagogy (Morales-Doyle, 2017). The participating LEA is one whose teacher leaders participated in our survey.

The results of this study can also assist with creating a STEM teacher leader "garden," which can improve STEM teacher leaders' professional practice. The research results can also tailor professional learning experiences/opportunities to meet this garden's needs.

5 | RECOMMENDATIONS

At one Mid-Atlantic M-1 University, teachers participate in a graduate course entitled "Mathematics Education Leadership for Equity," which takes one approach to increasing STEM teachers' leadership skills. A significant project in this course is to have teachers utilize local data to identify an issue of inequity that they feel is influencing their students' academic performance in STEM-related courses. First, the course textbook suggested common inequities for the teachers to explore. Next, the teachers researched the identified inequity and how other settings addressed it. Then, the teachers had to articulate an action plan to address this inequity. This helped teachers use a data-driven approach to consider how they might be able to take action to provide a more inclusive environment in which to teach STEM responsibly.

Bartell (2013) provides another possible approach to increasing teachers' self-efficacy and agency to teach STEM: empowering them to teach lessons that apply to the students' lived experiences. Gutstein (2003) found using STEM lessons relating to social justice aspects in urban settings beneficial. An idea behind teaching STEM content through the lens of social justice is to show students how various analyses are tools that can explain and confront biases or injustices that they might experience and help them become informed about actions that they can take to reduce the biases or injustices in those situations (Gutstein & Peterson, 2013). Within the graduate course sequence for the respondents, several courses taught by other faculty members utilize this social justice instructional approach so that the teachers feel prepared to teach STEM lessons through a social justice lens.

Kelley et al. (2020) propose a community of practice model to enhance STEM teachers' self-efficacy. By collaborating with various stakeholders and engaging in the development of integrated STEM activities, teachers can improve their skills and abilities while benefiting from the collective expertise and support of the community.

The Every Student Succeeds Act (ESSA) Title II, Part A (Every Student Succeeds Act, 2015), focuses on supporting effective instruction. LEAs can use these funds to implement professional growth and improvement systems for educators, including opportunities for meaningful teacher leadership. Federal funding can be utilized to provide professional learning opportunities to educators who work with students who have various disabilities, who are multilingual learners, and in various settings (Marten, 2022). The areas of funding examples are directly related to some of the major challenges identified by the survey respondents. The effectiveness and outcomes of future research and professional learning initiatives may provide the basis for accessing these funds and supporting the implementation of professional learning opportunities.

By considering and implementing these approaches, universities, LEAs, and policymakers can contribute to developing STEM teacher leaders equipped to address equity, incorporate social justice, engage in communities of practice, and provide practical instruction; they ultimately benefit students' STEM education experiences.

6 | CONCLUSIONS

The data from this study offer valuable evidence supporting the significant relationships between teachers' self-efficacy, agency, the formality of their leadership roles, values, and their views on leadership. These findings provide important insights for designing future professional learning experiences targeted at STEM teacher leaders.

Based on these relationships, professional learning experiences must focus on enhancing teachers' self-efficacy and agency. By providing opportunities for skill development, support, and resources, these experiences empower teachers to believe in their abilities to positively impact student learning and take proactive action in their leadership roles. Mentoring, collaboration, and reflective practices can be incorporated to strengthen teachers' self-efficacy and agency.

In addition, professional learning experiences should address the formation and solidification of teachers' values. By promoting discussions and activities exploring the alignment between teachers' values and their leadership practices, these experiences can help teachers understand the importance of their values in guiding their leadership decisions and actions. Creating a supportive and inclusive environment that respects diverse perspectives and values further enhances a teacher's sense of purpose and commitment to their leadership roles.

Future professional learning experiences for STEM teacher leaders should aim to improve self-efficacy and agency while fostering a deeper understanding and integration of their values. By addressing these factors, teachers can become more effective and confident leaders, positively impacting student learning and overall school improvement.

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CONFLICT OF INTEREST STATEMENT

The authors have no conflicts of interest to disclose.

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REFERENCES

Balgopal, M. M. (2020). Stem teacher agency: A case study of initiating and implementing curricular reform. *Science Education*, *104*(4), 762–785. https://doi.org/10.1002/sce.21578

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, *84*(2), 191–215. https://doi.org/10.1037/0033-295x.84.2.191

Bandura, A. (1994). Self-efficacy. In V. S. Ramachaudran (Ed.), *Encyclopedia of human behavior* (Vol. 4, pp. 71–81). Academic Press.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, *52*(1), 1–26. https://doi.org/10.1146/annurev.psych.52.1.1

Bardi, A., & Schwartz, S. H. (2003). Values and behavior: Strength and structure of relations. *Personality and Social Psychology Bulletin*, *29*(10), 1207–1220. https://doi.org/10.1177/0146167203254602

Bartell, T. G. (2013). Learning to teach mathematics for social justice: Negotiating social justice and mathematical goals. *Journal for Research in Mathematics Education*, *44*(1), 129–163. https://doi.org/10.5951/jresematheduc.44.1.0129

Barth, S. G., Lotter, C., Yow, J. A., Irdam, G., & Ratliff, B. (2023). Understanding the process of teacher leadership identity development. *International Journal of Leadership in Education*, *1–28*, 1–28. https://doi.org/10.1080/13603124.2023.2258083

Bronfenbrenner, U. (1977). Toward an experimental ecology of human development. *American Psychologist*, *32*(7), 513–531. https://doi.org/10.1037/0003-066x.32.7.513

Carver-Thomas, D., & Darling-Hammond, L. (2017). *Teacher turnover: Why it matters and what we can do about it*. Learning Policy Institute. https://doi.org/10.54300/454.278

Criswell, B. A., Rushton, G. T., Nachtigall, D., Staggs, S., Alemdar, M., & Cappelli, C. J. (2018). Strengthening the vision: Examining the understanding of a framework for teacher leadership development by experienced science teachers. *Science Education*, *102*(6), 1265–1287. https://doi.org/10.1002/sce.21472

Derrington, M. L., & Angelle, P. S. (2013). Teacher leadership and collective efficacy: Connections and links. *International Journal of Teacher Leadership*, *4*(1), 1–13.

Every Student Succeeds Act. (2015). 20 U.S.C. § 6301. https://www.congress.gov/bill/114th-congress/senate-bill/1177

Fuller, E. J., & Pendola, A. (2019). *Teacher preparation and teacher retention: Examining the relationship for beginning STEM teachers*. American Association for the Advancement of Science.

Gutstein, E. (2003). Teaching and learning mathematics for social justice in an urban, Latino school. *Journal for Research in Mathematics Education*, *34*(1), 37. https://doi.org/10.2307/30034699

Gutstein, E., & Peterson, B. (2013). *Rethinking mathematics: Teaching social justice by the numbers* (2nd ed.). Rethinking Schools Publication.

Hadar, L. L., & Benish-Weisman, M. (2018). Teachers' agency: Do their values make a difference? *British Educational Research Journal*, *45*(1), 137–160. https://doi.org/10.1002/berj.3489

Hite, R., Smith, J. F., Spuck, T., Dou, R., Milbourne, J., & Vieyra, R. E. (2020). STEM teacher leadership in policy. In C. C. Johnson, M. J. Mohr-Schroeder, T. J. Moore, & L. D. English (Eds.), *Handbook of research on STEM education* (1st ed., pp. 470–480). Routledge, Taylor & Francis Group.

Hogg, M. A., Terry, D. J., & White, K. M. (1995). A tale of two theories: A critical comparison of identity theory with social identity theory. *Social Psychology Quarterly*, *58*(4), 255–269. https://doi.org/10.2307/2787127

Hutchinson, A. E., Schaefer, J., Zhao, W., & Criswell, B. (2022). Practice, tensions, and identity: Boundary crossing and identity development in urban teacher leaders. *Journal of Research on Leadership Education*, *18*(4), 575–599. https://doi.org/10.1177/19427751221113368

Kasapoğlu, H., & Karaca, B. (2021). Teachers' views on teacher leadership: A qualitative analysis. *International Journal of Progressive Education*, *17*(6), 66–82. https://doi.org/10.29329/ijpe.2021.382.5

Kelley, T. R., Knowles, J. G., Holland, J. D., & Han, J. (2020). Increasing high school teachers self-efficacy for integrated STEM instruction through a collaborative community of practice. *International Journal of STEM Education*, *7*(1), 1–13. https://doi.org/10.1186/s40594-020-00211-w

Klassen, R. M., Tze, V. M., Betts, S. M., & Gordon, K. A. (2010). Teacher efficacy research 1998–2009: Signs of progress or unfulfilled promise? *Educational Psychology Review*, *23*(1), 21–43. https://doi.org/10.1007/s10648-010-9141-8

Knapp, M. C. (2017). An autoethnography of a (reluctant) teacher leader. *The Journal of Mathematical Behavior*, *46*, 251–266. https://doi.org/10.1016/j.jmathb.2017.02.004

Kock, N. (2022). *WarpPLS user manual: Version 8.0*. ScriptWarp Systems.

Leonard, J., Blondonville-Ford, D., Cheng, D., Grubb, D., Lombardi, D., & Wang, X. (2023). Understanding the contributions of self-efficacy, agency, and values to STEM teacher leadership in urban-like settings. Teachers' motivation and motivating instructional practices. American Educational Research Association annual conference, Chicago, IL. https://doi.org/10.3102/2006447

Liu, S., Hallinger, P., & Feng, D. (2016). Supporting the professional learning of teachers in China: Does principal leadership make a difference? *Teaching and Teacher Education*, *59*, 79–91. https://doi.org/10.1016/j.tate.2016.05.023

Lyons, L. (2022). Stop teacher turnover! Practical tips within a school principal's control and the research behind retaining good teachers. https://www.learningsciences.com/blog/teacher-turnover/

Marten, C. (2022). Key policy letters signed by the Education Secretary or Deputy Secretary: Using federal funds to support innovative, equity-focused pre-kindergarten through grade 12 (Pre-K–12) STEM education strategies. https://www2.ed.gov/policy/gen/guid/secletter/221206.html?utm_content=&utm_medium=email&utm_name=&utm_source=govdelivery&utm_term=

Milner, H. R. (2012). But what is urban education? *Urban Education*, *47*(3), 556–561. https://doi.org/10.1177/0042085912447516

Morales-Doyle, D. (2017). Justice-centered science pedagogy: A catalyst for academic achievement and social transformation. *Science Education*, *101*(6), 1034–1060. https://doi.org/10.1002/sce.21305

Priestley, M., Biesta, G. J., & Robinson, S. (2016). Chapter 10: Teacher agency: What is it and why does it matter? In J. Evers & R. Kneyber (Eds.), *Flip the system: Changing education from the ground up* (pp. 1–11). Routledge.

Reinartz, W., Haenlein, M., & Henseler, J. (2009). An empirical comparison of the efficacy of covariance-based and variance-based SEM. *International Journal of Research in Marketing*, *26*(4), 332–344. https://doi.org/10.1016/j.ijresmar.2009.08.001

Riggs, I., & Knochs, L. (1990). Towards the development of an elementary teacher's science teaching efficacy belief instrument. *Science Education*, *74*, 625–637.

Saldaña, J. (2021). *The coding manual for qualitative researchers*. SAGE Publications Ltd.

Schwartz, S. H. (2003). *A proposal for measuring value orientations across nations* (pp. 259–290). Questionnaire Package of the European Social Survey.

Schwartz, S. H. (2012). An overview of the Schwartz theory of basic values. *Online Readings in Psychology and Culture*, *2*(1), 1–20. https://doi.org/10.9707/2307-0919.1116

Schwartz, S. H. (2017). The refined theory of basic values. In S. Roccas & L. Sagiv (Eds.), *Values and Behavior* (pp 51–72). Springer. https://doi.org/10.1007/978-3-319-56352-7_3

Schwartz, S. H., Cieciuch, J., Vecchione, M., Davidov, E., Fischer, R., Beierlein, C., Ramos, A., Verkasalo, M., Lönnqvist, J.-E., Demirutku, K., Dirilen-Gumus, O., & Konty, M. (2012). Refining the theory of basic individual values. *Journal of Personality and Social Psychology*, *103*(4), 663–688. https://doi.org/10.1037/a0029393

Schwartz, S. H., Melech, G., Lehmann, A., Burgess, S., Harris, M., & Owens, V. (2001). Extending the cross-cultural validity of the theory of basic human values with a different method of measurement. *Journal of Cross-Cultural Psychology*, *32*(5), 519–542. https://doi.org/10.1177/0022022101032005001

Simon, N., & Johnson, S. M. (2015). Teacher turnover in high-poverty schools: What we know and can do. *Teachers College Record: The Voice of Scholarship in Education*, *117*(3), 1–36. https://doi.org/10.1177/016146811511700305

Stets, J. E., & Burke, P. J. (2000). Identity theory and social identity theory. *Social Psychology Quarterly*, *63*(3), 224–237. https://doi.org/10.2307/2695870

Tschannen-Moran, M., & Hoy, A. W. (2001). Teacher efficacy: Capturing an elusive construct. *Teaching and Teacher Education*, *17*(7), 783–805. https://doi.org/10.1016/s0742-051x(01)00036-1

Velasco, R. C., Hite, R., & Milbourne, J. (2021). Exploring advocacy self-efficacy among K-12 stem teacher leaders. *International Journal of Science and Mathematics Education*, *20*(3), 435–457. https://doi.org/10.1007/s10763-021-10176-z

Wenner, J. A. (2017). Urban elementary science teacher leaders: Responsibilities, supports, and needs. *Science Educator*, *25*(2), 117–125.

Wenner, J. A., & Campbell, T. (2016). The theoretical and empirical basis of teacher leadership. *Review of Educational Research*, *87*(1), 134–171. https://doi.org/10.3102/0034654316653478

Xie, C., Song, P., & Hu, H. (2020). Measuring teacher leadership in different domains of practice: Development and validation of the teacher leadership scale. *The Asia-Pacific Education Researcher*, *30*(5), 409–419. https://doi.org/10.1007/s40299-020-00527-9

York-Barr, J., & Duke, K. (2004). What do we know about teacher leadership? Findings from two decades of scholarship. *Review of Educational Research*, *74*(3), 255–316. https://doi.org/10.3102/00346543074003255

Yow, J. A., Lotter, C., & Criswell, B. (2021). The need for STEM teacher leadership. *School Science and Mathematics*, *121*(3), 123–126. https://doi.org/10.1111/ssm.12461

Zavelevsky, E., & Lishchinsky, O. S. (2020). An ecological perspective of teacher retention: An emergent model. *Teaching and Teacher Education*, *88*, 102965. https://doi.org/10.1016/j.tate.2019.102965

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