The Future of Engineering Education
2024 Annual Conference & Exposition
Oregon Convention Center
Portland, OR . June 23 - 26, 2024
ASEE
Paper ID #42456

Exploring Funds of Knowledge and Social Capital of Migratory Students in STEM: Revised Instrument

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Abstract. Migratory/seasonal farmworker (MSFW) families in the United States are defined as those living a mobile lifestyle following the crops across the country. The mobile lifestyle of migratory families impacts their children by creating financial instability, structural barriers, and interruptions to their education. This inconsistent access to high-quality education as a result of frequent moves and lack of resources in the regions they live in has pushed and ignored migratory students out of the popular conversation in Science, Technology, Engineering, and Mathematics (STEM) regarding broadening participation. Thus, this work revised existing measures of the frameworks of funds of knowledge and social capital, which will help to empirically examine how bodies of knowledge (e.g., skills, experiences, and knowledge accumulated from home) are transformed and supported by migratory students' circles of influence (e.g., social networks and community assets that assist students in navigating social structures) given their unique context of being MSFW students in STEM education. A survey was distributed to program directors of the College Assistance Migrant Program (CAMP), which is a federally funded program that assists children of migratory families during their first year of college. The survey was created from two prior validated instruments on funds of knowledge and community cultural wealth. A total of 108 undergraduate migratory students in STEM fields who were either previously or currently associated with CAMP responded to the survey. Exploratory and confirmatory factor analyses were used to confirm the underlying theoretical relationships between the survey items and the predicted constructs. Results supported a two latent construct model with six items that make up the instrument: 1.) knowledge/experience outside of school and 2.) social networks in the form of neighborhood friends. These results add to the ongoing conversation of combining the frameworks of funds of knowledge and with forms of capital (e.g., social capital) to create one that is more comprehensive and identify specific networks and places that support the development of funds of knowledge of underrepresented students in STEM. The results from our study suggest that migratory student's neighborhood friends play a significant role in the development, activation or exchange of funds of knowledge to navigate STEM spaces.

I. Introduction

Migratory/seasonal farmworker (MSFW) families are defined as those who follow the crops from across the country [1], and as stated by Green, "Mobility is not just another variable in the life of the migrant child, it is the child's life. It defines the child's world and his/her relationship with the world" [2, p. 62]. This mobility lifestyle of MSFW families is the most impactful due to financial instability, structural barriers, and interruption of their children's education [3], [4]. Yet, these families produce the food we all eat with our families and are a vital source of labor in the United States [5]. Despite their significant contributions to society and the economy, these families continue to be among the lowest income groups and have lower levels of educational achievement in the U.S. [6], [7]. This is due to the fact that these families typically reside in marginalized areas, resulting in schools with low monetary resources and access to STEM activities and resources, which puts them at a disadvantage to the rest [8], [9], [10].

In accordance with the Office of Migrant Education, which manages grant programs to support and assist the children of migratory families [11], close to one million migrant students have been identified in the nation, and the vast majority are of Latino/a/x heritage [12]. In accordance with the U.S. 2020 Census, this population is considered the second largest racial/ethnic group in the U.S. [13], but despite this demographic trend that keeps increasing, they continue to be underrepresented in STEM disciplines [14]. The aim of this research is to apply Yosso's [15] concepts of capital, specifically social capital, derived from the Community Cultural Wealth (CCW) framework, to examine undergraduate STEM students who come from MSFW backgrounds and use it to inform the Funds of Knowledge (FofK) conceptual framework. In turn, the new instrument can aid in enhancing the knowledge of the academic community regarding the abilities and obstacles faced by students from MSFW backgrounds and help gather evidence to create a culturally responsive curriculum.

II. Theoretical Background

The conceptual framework FofK was developed in the 1990s, and it refers to skills, experiences, and technical knowledge created from everyday life experiences, particularly in households [16]. Essentially, households are places of learning where not only knowledge is acquired but also social and cultural networks are exchanged. These exchanges occurred through family rituals and visitations, where extended family, friends, or community members provided support during times of scarcity [17]. Prior work on FofK has demonstrated its positive effects on students' academic performance. For example, Volman's [18] intervention consisted of teachers implementing several activities and ways to show and build students' funds of knowledge and identity through the course of a school year, which revealed positive results on attitudes, involvement, teamwork, confidence, and overall well-being. Another study unveiled that students from the lowest income groups were more engaged and maintained an interest in science when they could use their own experiences and knowledge to make science more relevant [19]. Verdin et al. [20] discovered that minoritized students' confidence in choosing to major in engineering was supported when they could openly see connections between their lived experiences (FofK) and engineering.

According to Bourdieu [21], who developed the social capital theory, social capital is available to those who acquire it by achieving positions of power; in other words, it is tied to class, which in turn is linked to various forms of advantage and benefit. The CCW framework, which is grounded in critical race theory, is useful to describe how people of color possess unique cultural assets fostered by their families and communities but which are frequently undervalued or ignored in society [15]. With that, Yosso proposed six types of capital (i.e., aspirational, linguistic, navigational, resistant, social, and familial) that can help students from communities of color along their educational journeys [15]. According to Yosso [15], social capital is defined as places emphasizing the social networks and community assets that may assist families and students in navigating social structures. Both FofK and social capital (from the CCW framework) are interconnected, given their focus on community assets (i.e., people and places) and their significant contribution to supporting educational success. However, these frameworks approach these assets from different angles. Funds of knowledge primarily focus on an individual's skills, lived experiences, and technical knowledge, while social capital emphasizes the circles of influence that contribute to the funds of knowledge. Thus, combining them can provide a better understanding of how underrepresented groups (e.g., MSFW students) convert or exchange their funds of knowledge and social capital to navigate STEM spaces.

As stated above, FofK concentrates on students' families, lived experiences, and community resources, all of which are impacted by social capital [22], [23], [24]. For example, Stanton-Salazar and Dornbusch [25] mentioned that social capital and FofK are essential for minoritized students' academic success. Their findings showed significant results on how the accumulation and acquisition of social capital are tied to social class, which is also reflected in students' performance and access or lack of funds of knowledge. In another publication, Stanton-Salazar [26] also talked about how minoritized students attend schools with lots of cultural resources (which come from family and social networks) and FofK, but the school is not designed to value or use these experiences to better serve these students. Alluding to this same cause is Zipin's publication, "…institutional mechanisms will operate to inhibit curricular and pedagogic take-up of cultural knowledge practices embodied among learners from less powerful families, in privileging the embodied codes and norms of power-elite families" [27, p. 326]. Further, Zipin [27], [28] has argued that knowledge encompasses sources of capital (e.g., social) and funds of knowledge, which allows for someone to succeed more easily given their access to both. Similarly, Rios-Aguilar et al. [29] claimed that FofK and forms of capital (social) give students access to educational opportunities and experiences, allowing them to navigate the system more easily. This will not only allow students to be seen and receive an education that recognizes their cultural diversity but also allow them to learn and succeed. Smith & Lucena [30] looked at how low-income, first-generation students use their FofK to belong to engineering. Findings from this piece showed how students were not aware of their FofK, but when the concept was introduced to them, they aimed to practice engineering in a way that valued and welcomed their home experiences and interactions with social networks. The concept of FofK is compelling, as demonstrated by this example. Students did not simply "adapt" to the status quo but instead liberated themselves and tapped into their funds of knowledge. As seen, students, via their social capital (or social networks), obtained and exchanged funds of knowledge. Not only does theory convey this phenomenon, but the work presented above demonstrates that students' social networks afforded them various types of funds of knowledge. With that, the aim of this work is to demonstrate how access to social capital can contribute to migratory students' activation, use, and exchange of their funds of knowledge in STEM fields given the unique context where they reside. In addition, the results aimed to support this idea of combining these frameworks (funds of knowledge and social capital) together to create one that is more comprehensive, as suggested by several scholars [15], [29], [31], [32].

III. Methods

This study aims to add to the literature by revising existing measures of the frameworks of funds of knowledge and social capital, which will help to empirically examine how combining them can provide a better understanding of how underrepresented groups (e.g., MSFW students) convert or exchange their funds of knowledge and social capital to navigate STEM spaces. This will be accomplished by answering the following questions:

> *RQ1:* Can a scale that combines funds of knowledge and social capital be created to meet validity standards tailored to the unique context of MSFW students in STEM fields?

A. Construct Generation

The survey instrument in this study was a combination of two existing validated instruments on Community Cultural Wealth (CCW) and Funds of Knowledge (FofK). One of the instruments is from a conference proceeding on ASEE titled *Critically Quantitative: Measuring Community Cultural Wealth on Surveys* [33], which was developed by looking at underrepresented groups in STEM fields. While the instrument in the study is consistent with Yosso's [15] framework and goes deeper in detail about the type of constructs for CCW. For this study, only the social construct (10 items) was used and renamed as social networks. The second instrument comes from a journal paper titled *Recognizing the funds of knowledge of first-generation college students in engineering: An instrument development* [24]. While the instrument here focused on engineering students, it can be used on STEM students. This is true as engineering makes use of and combines STEM subjects like science, technology, and math. On top of that, STEM and engineering fields are characterized as rigorous fields and students in both fields apply and learn critical thinking and problem-solving skills in their curriculum. Thus, STEM and engineering can be considered similar fields in terms of their focus on science, technology, and mathematics and their application to real-world problems. From this instrument, this study has modified the construct names and items slightly to accommodate the target population of undergraduate students with migratory/seasonal farmworker (MSFW) backgrounds in STEM. It is important to note that the author of this piece has vast experience working with students with MSFW backgrounds and possesses experiences that mirror the participants' experiences, which aid during the modification of some survey items. The "funds of knowledge" construct (10 items) is a fusion of connecting experiences and tinkering knowledge from home. In total, this new survey instrument consists of 27 items, seven of which covered demographic information from the participants. Meanwhile the remaining 20 items use a 5-point Likert scale ranging from "1-strongly disagree/not all true" to "5-strongly agree/very true" for each of the items/statements. For example, "The experiences I gained in my free time have helped me in my STEM coursework" or "Friend(s) from my neighborhood have given me advice that helped me in my STEM coursework."

B. Sample and Data Collection

Approval was obtained to conduct this study as per Institutional Review Board (IRB) guidelines. The survey instrument was distributed to directors of the College Assistance Migrant Program (CAMP) across the nation, who supported the distribution of the survey to students with MSFW backgrounds in STEM fields, which yielded a total of 108 participants (n=108). Participants had a month to complete the survey, and to boost their participation, a random drawing of five e-gift cards from the pool of participants was offered as an incentive. The CAMP program was chosen because it is federally funded and assists children of MSFW during their first year of college [34]. Reaching out to all the CAMP programs in the country provided a diverse geographical location in our participant pool, as displayed in Figure 1. It is worth noting that our sample is representative of the migrant population and its regional concentration levels, according to the U.S. Bureau of Labor Statistics [35]. Table 1 shows a breakdown of the demographic information presented in the sample.

Table 1. Demographic Information

Demographic Categories		n (%)
Gender	Male	62 (57)
	Female	45 (42)
Ethnicity	Hispanic, Latino/x/e, or Spanish Origin	102 (95)
	Other or multiple ethnicities	5 (5)
Year in School	First-year	39 (36)
	Second year	23 (21)
	Third year	14 (13)
	Fourth year	22 (21)
	Fifth year	9 (9)
Field of Study	Science	61 (56.5)
	Engineering	41 (38)
	Math	3 (3)
	Technology	1 (1)

Figure 1. Students with MSFW backgrounds respondents' location

C. Exploratory Factor Analysis

The data set (n=108) was randomly divided into two samples without replacement to run both the exploratory factor analysis (EFA) and the confirmatory factor analysis (CFA). Splitting the data in two sets is recommended when conducting both analyses and to ensure an equal number of STEM students with MSFW backgrounds in both datasets.

For the dataset$_1$ (n_1=54), to ensure its quality, measures such as control questions and imputation techniques were implemented to deal with the missing data. Based on the exploratory data analysis (i.e., mean (M), standard deviation (SD), skewness (S), and kurtosis (K)), normality was examined using the S and K rule of thumb for sample size $50 < n < 300$. This indicates that z-scores for S and K should be within ± 2.58. In this case, all the values were within the range. The variables were also examined to determine their factorability by looking at the correlation values and evaluating if they fall within the acceptable range of 0.3 to 0.8; based on the results from the correlation matrix, all of the items fall outside the acceptable range.

Then for dataset$_1$ an exploratory factor analysis (EFA) was implemented to determine the factor structure and to identify any candidate items for deletion. First, the sample adequacy was examined using Bartlett's and Kaiser-Meyer-Olkin (KMO) tests. Based on both tests, it was concluded that the sample was adequate for factor analysis, KMO=0.723 (that is, KMO>0.6), and Bartlett's test, p<0.001. To determine the number of factors to extract three different techniques were used: Kaiser's criterion, Parallel analysis, and Scree plot. Parallel analysis provides a more objective criterion than the other two methods and compares the data's eigenvalues with a completely random sample to determine the appropriate number of common factors [36], which provides a two-factor solution. With that, the extraction technique of Principal Axis Factoring (PAF) was used along with the Oblique (Promax) rotation approach.

From the Pattern Matrix, any cross-loaded items and items below the threshold of 0.32 were removed. This process of removing items was followed in an iterative process until the remaining survey items met the criteria of not being cross-loaded and above the 0.32 threshold. The inter-item correlation matrix values were examined for homogeneity for both factors. Table 2 displays the factor structure of eleven survey items identified and supported by our analysis. Factor 1 was interpreted as *knowledge/experience outside of school*, which has six survey items. This is an appropriate interpretation and name for the latent construct, as the survey items demonstrated a clear connection between lived experiences from outside of school in support and connection with STEM concepts. Then Factor 2 was translated as *social networks*, which has five survey items. The rationale for this construct became clear from how the survey items captured the importance of circles of influence for students' success in STEM disciplines.

Table 2. EFA Factor Solution

Survey Item	Factor 1 (Knowledge/experience outside of school)	Factor 2 (Social Networks)
Q8_c: I see connections between experiences at home and what I am learning in my courses.	0.728	
Q8_e: At home, I learned to use tools that have helped me in my STEM coursework.	0.769	
Q8_f: The skills I have gained from home have helped me in my STEM coursework	0.616	
Q8_h: The care giving techniques I know have helped me in my STEM coursework.	0.779	
Q8_i: The experiences I gained in my free time have helped me in my STEM coursework.	0.978	
Q8_j: The knowledge I have gained outside of school have helped me in my STEM coursework.	0.776	
Q9_a: Friend(s) from my neighborhood have given me advice that helped me in my STEM coursework.		0.933
Q9_b: Friend(s) from my neighborhood have given me resources that helped me in my STEM coursework.		0.982
Q9_c: Friends(s) from my neighborhood have given me emotional support that helped me continue my STEM coursework.		0.647
Q9_e: Coworker(s) or mentors have given me advice that helped me with my STEM coursework.		0.786
Q10_a: I draw on connections with individual faculty to be successful in college.		0.552

D. Confirmatory Factor Analysis

Dataset$_2$ (n_2=54) was used to run CFA. We examined assumptions of univariate and multivariate skewness and kurtosis. Univariate levels of skewness and kurtosis were examined within this new dataset; all variables were within the acceptable range (i.e., z-scores for skewness and kurtosis should be within ± 2.58). Multivariate normality was examined using Mardia's test, which yielded a violation of multivariate normality. Therefore, the Satorra-Bentler adjusted chi-square test for goodness fit was used to adjust due to the lack of multivariate normality.

After a couple of iterations, some of the items that did not meet the appropriate standards were removed, which resulted in the Satorra-Bentler chi-square yield $SB\chi^2$=2.831 df=8, p=0.944. The fit indexes were CFI of 1.000, TLI of 1.000, RMSEA of 0.000 CI (0.000 – 0.032), and SRMR of 0.027. Both the CFI and TLI values were above 0.90, indicating a good model fit [37]. The RMSEA value was below the recommended value of 0.080, reflecting a good model fit with an upper interval limit value also below 0.080 [38]. Lastly, the SRMR value was below the acceptable value of 0.05 [38]. The final model's factor loadings can be found in Table 3, and Figure 2 demonstrates the factor structure.

Further, the scale's internal consistency was evaluated using item reliability, construct reliability (α), and average variance extracted (AVE), which can be found in Table 3 as well. All standardized factor loadings were above the recommended 0.60 minimum. Item reliability ranged from 0.619 to 0.908. The AVE values for knowledge/experience outside of school and social networks were within the acceptable range of 0.69 and 0.78, respectively [39]. The internal consistency, examined using Cronbach (α), was 0.87 for knowledge/experience outside of school and 0.91 for social networks, both above 0.7, indicating good construct reliability [40]. It is important to highlight that our final structure for Factor 2 is only about neighborhood friends, which will be addressed in the discussion section. Overall, we have gathered sufficient evidence of reliability to conclude that the latent constructs and their respective items capture aspects of students' funds of knowledge.

Table 3. Confirmatory factor analysis results

Latent construct Survey items	Standard factor loading	SE	Item reliability	α	AVE
Knowledge/experience outside of school				0.87	0.69
Q8_f: The skills I have gained from home have helped me in my STEM coursework	0.833	0.155	0.695		
Q8_i: The experiences I gained in my free time have helped me in my STEM coursework.	0.879	0.112	0.773		
Q8_j: The knowledge I have gained outside of school have helped me in my STEM coursework.	0.787	0.147	0.603		
Social Networks				0.91	0.78
Q9_a: Friend(s) from my neighborhood have given me advice that helped me in my STEM coursework.	0.913	0.102	0.834		
Q9_b: Friend(s) from my neighborhood have given me resources that helped me in my STEM coursework.	0.953	0.096	0.908		
Q9_c: Friends(s) from my neighborhood have given me emotional support that helped me continue my STEM coursework.	0.787	0.141	0.619		

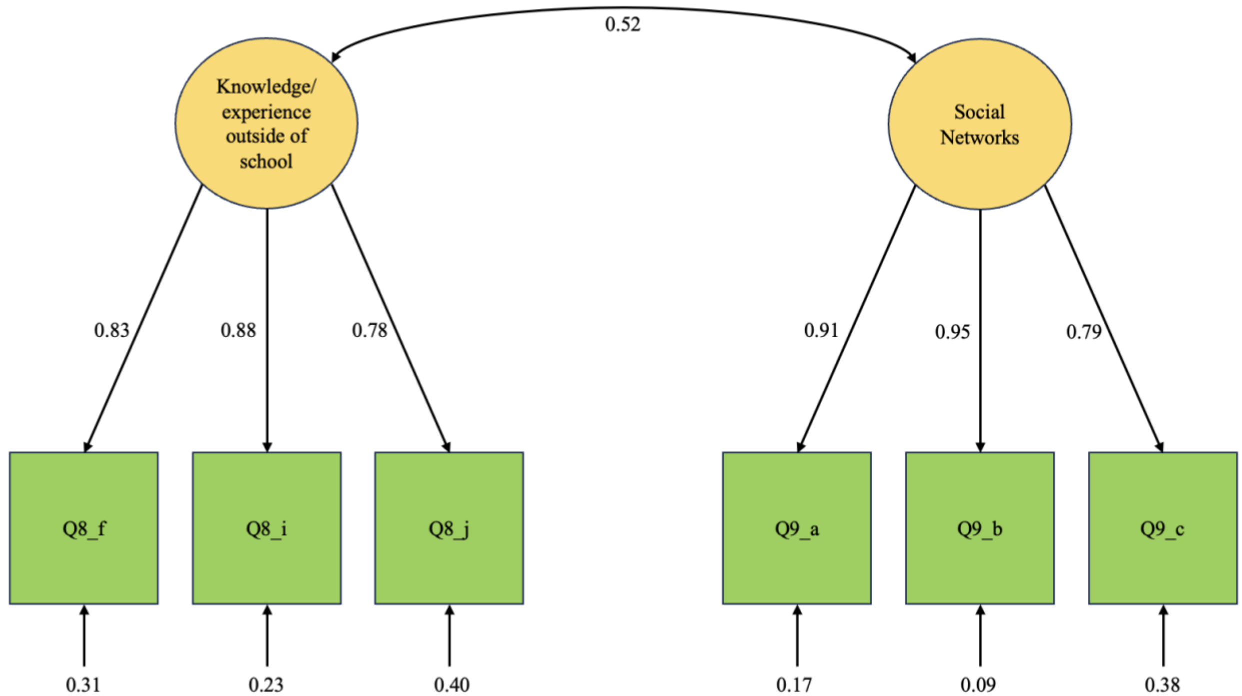

Figure 2. Factor structure model

IV. Discussion

The goal of this study was to revise and validate a survey that captures the funds of knowledge and social capital of migratory/seasonal farmworker students in STEM fields. The intention was to move forward the conversation of combining these frameworks to create one that is more comprehensive, which can provide a broader angle and a better understanding of how underrepresented groups (e.g., MSFW students) convert or exchange their funds of knowledge and social capital to navigate STEM spaces. To accomplish this goal, the research question: (1) Can a scale that combines funds of knowledge and social capital be created to meet validity standards tailored to the unique context of MSFW students in STEM fields? served as a guide for the study. The two prior validated instruments on funds of knowledge and CCW, from which only social capital was used, were fundamental for the creation of the instrument. According to the sources of validity evidence explored (i.e., exploratory factor analysis and confirmatory factor analysis), the items adequately represent both knowledge/experience outside of school (funds of knowledge) and social networks (neighborhood friends) that were intended to be tested and revised during this process.

While the final structure of the instrument is modest in size, its nature suggests the importance that social networks, in this case, neighborhood friends, have on migratory students' funds of knowledge in STEM. Scholars such as Rios-Aguilar et al. [29] asserted that FofK and forms of capital (social and cultural) open doors to educational possibilities and experiences for students as they navigate the system through the exchange of forms of capital and FofK. While this conversion between forms of capital and FofK might be happening, a factor that might contribute to it is class, just like Bourdieu [21] and Stanton-Salazar and Dornbusch [25] claimed that social and cultural capital varies with social class. Therefore, a person's social class will impact access to forms of capital, and in the case of migratory students the neighborhood friends they interact with which in turn will also affect access or integration of FofK. The emergence of neighborhood friends as significant contributors to funds of knowledge for migratory students in STEM highlights the complex interplay between social dynamics and individual experiences in these settings. Our study suggests that the way people interact with others, especially their friends in their neighborhood, significantly impacts how they navigate challenging STEM environments. This finding emphasizes the need to consider social networks and support systems when studying the experiences of underrepresented students such as migratory students in STEM spaces. These results align with Bejarano and Valverde's [41] piece, in which findings demonstrated that students with MSFW access to forms of capital are used to navigate new spaces such as higher education. Also, Kiyama's [22] case study on the aspirations of children from Mexican American families, where she used social and cultural capital documented how these families and other close networks are the first providers of educational experiences and aspirations for their children to pursue higher education. Additionally, Castillo and Verdin [42] found that community networks, including neighborhood friends, help Latinx students with their engineering coursework, consequently supporting their external recognition, sense of belonging, and persistent beliefs. As such, the instrument here suggests the significance of social networks, in this case, neighborhood friends of migratory students, in the development, activation, or exchange of funds of knowledge to navigate STEM spaces.

The results in this piece not only provide an initial insight into the role of neighborhood friends for migratory students in STEM, but also underlines the need for continued exploration and refinement to create a more comprehensive framework to explore funds of knowledge. As stated, many pioneer scholars [15], [29], [31], [32] have alluded to the benefits of combining funds of knowledge with forms of capital to form one more complementary. As such, this paper makes a call to explore the combination of the frameworks further, as it is critical to identify specific networks and places that cultivate the funds of knowledge of students. By identifying specific networks and places where students acquired more of their funds of knowledge, it is possible to enable more inclusive, culturally responsive, and empowering techniques in higher education spaces, particularly in STEM. Thus, recognizing and acknowledging the circles of influence, lived experiences, and assets that individuals such as MSFW students bring to STEM spaces can lead to more equitable and effective academic outcomes.

V. Limitations

This study acknowledges several limitations. One is that this a unique study in the sense that it explores the combination of FofK and social capital on students with MSFW backgrounds in STEM. Therefore, no previous work has explored this topic with this particular group of participants, which created a lack of previous work to compare our results. Another constraint was our sample size, gender and field of study representation, pools were not represented equally. Additionally, while significant results were obtained, the sample was not normally distributed. Lastly, the author of this paper recognizes that while the instrument meets standards of validity evidence, the instrument is small and has the minimum number of survey items per latent construct.

VI. Implications, future work, conclusions

Our findings add to a growing body of literature highlighting the vital role of community networks, such as neighborhood friends, in supporting students' academic success and sense of belonging in STEM fields. In addition, this study expanded on the existing literature on students with MSFW backgrounds in higher education, particularly in STEM spaces. These findings strengthened previous work by other scholars [15], [29], [31], [32] and their call to combining FofK and forms of capital to generate a complementary framework, which can be used to understand the educational convolutions that continue affecting underrepresented groups in STEM fields and in the higher education arena at large. Most importantly, this study demonstrated the importance of neighborhood friends to support students with MSFW backgrounds FofK in STEM, as they are a significant portion of the student population. The findings here will help faculty and administrators in STEM understand this population of student as they have mostly been "invisible" in the STEM conversation. Therefore, this work can bring these students to the forefront for STEM educators to understand that they are part of the student population and possess unique assets that they bring to the classroom.

Future research recommendations include looking at the income of students' families to see how significantly it affects their access to social capital and funds of knowledge. Also, looking at students by field of study, that is, Science, Technology, Engineering, and Mathematics separately. With that, a comparison between the different fields of study can be beneficial to understanding similarities and differences between fields and possible variations in terms of whether the field of study influences access to more or less FofK. Further, this study only used social from Yosso's CCW framework, and future work can explore how other sources of capital, such as aspirational, linguistic, navigational, cultural, and resistant, manifest and possibly can also inform the FofK framework. Lastly, to understand more about the specific lived experiences students have access to, based on their sources of capital, which they bring to the classroom, a qualitative study focused on migratory students can be deployed. This would help the educational community further understand the strengths and barriers students with MSFW backgrounds possess and push for developing a culturally responsive curriculum.

In this study, the author examined how to combine FofK and sources of capital by looking at students with MSFW backgrounds in STEM fields. Specifically, the revised instrument meets standards of validity evidence tailored to the unique context of migratory students in STEM education. Based on the results obtained, it was observed that migratory students' social networks, specifically neighborhood friends, assist their accessibility, formation, and exposure to STEM-related experiences outside of the classroom, particularly at home, to navigate STEM spaces.

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