

Board 219: Asset-Based Practices in a Steam Middle School: Lessons Learned from Teachers' Perspectives

Dr. Joel Alejandro Mejia, The University of Texas, San Antonio

Dr. Joel Alejandro (Alex) Mejia is an Associate Professor with joint appointment in the Department of Biomedical and Chemical Engineering and the Department of Bicultural-Bilingual Studies at The University of Texas at San Antonio. His research has contributed to the integration of critical theoretical frameworks in engineering education to investigate deficit ideologies and their impact on minoritized communities. His work seeks to analyze and describe the assets, tensions, contradictions, and cultural collisions many Latino/a/x students experience in engineering through testimonios. He is particularly interested in approaches that contribute to a more expansive understanding of engineering in sociocultural contexts, the impact of critical consciousness in engineering practice, and the development and implementation of culturally responsive pedagogies in engineering education.

Dr. Alberto Esquinca, San Diego State University

Alberto Esquinca is an Associate Professor in the Department of Dual Language and English Learner Education at San Diego State University.

Luis E Montero-Moguel, The University of Texas, San Antonio

Luis Montero is a Ph.D. student in Interdisciplinary Learning and Teaching at the University of Texas at San Antonio, currently in his second year of study. He earned his Master's degree in Mathematics Teaching from the University of Guadalajara in Mexico and his Bachelor's degree in Mechanical Engineering from the Technological Institute of Merida, also in Mexico. With 11 years of experience teaching mathematics at the high school, engineering, and business bachelor levels, He has developed a comprehensive understanding of the needs of diverse student populations. He holds an iSTEAM certificate from the University of Texas at San Antonio and is currently pursuing his Engineering Education Graduate Certificate at the same institution. His research interests lie in creating equal opportunities for all students and developing research and teaching proposals in STEM-integrated education that promote quality, equity, inclusivity, and student-centered instruction. He also brings 18 years of experience in project engineering to his work, specializing in the design of stainless-steel equipment, stainless-steel piping, and welding.

Asset-based practices in a STEAM middle school: Lessons learned from teachers' perspectives

Abstract

This NSF-funded study sought to explore the ways in which middle school teachers developed an understanding and appreciation for funds of knowledge. The study provided teachers with opportunities to collaborate with a group of researchers with expertise in bilingual education, engineering education and learning sciences to create activities that integrated a funds of knowledge approach to their teaching. That is, the teachers explored the ways in which funds of knowledge could be used not only as a theoretical framework but also as a way to facilitate conversations in the classroom where students' ways of being, knowing and doing could be acknowledged and valued. Another aspect of this approach was to think about how funds of knowledge could be used as a tool to mediate access to science and engineering content. To counter the idea that language and STEM content are mutually exclusive, we also sought to challenge deficit models in STEM by co-constructing learning experiences with teachers and acknowledging the wealth of knowledge that Latino/a/x students possess. In this paper, we focus on the lessons learned from this project as the middle school teachers considered aspects of funds of knowledge and STEAM to develop and implement an engineering-related activity in their classes.

Introduction

The lack of access to engineering for Latinos/as/xs is not something that is unknown in engineering education research. Historically, deficit thinking, unequal school financing, poor access to resources, and different segregationist policies have institutionalized such inequities. Although Latino/a/x communities have resisted the imposition of inferior educational opportunities through organizing and activism in the U.S. Southwest primarily [1-3], educational oppression and school failure for Latinos/as/xs has been marked by institutional processes that have led to detrimental outcomes – particularly deficit thinking [4-6]. Even though deficit thinking has not been widely explored in engineering education research, there is a growing push for asset-based perspectives [7-9].

Despite the resistance of the Mexican and Mexican American communities in the U.S. Southwest (one of the areas with the largest proportion of Latino/a/s students) against unfavorable policies that have negatively impacted their educational attainment, the borderlands continue to have “the longest and most pronounced history of inferior education in regard to Chicano students” [6]. For example, after the Treaty of Guadalupe Hidalgo was signed, and as the Anglo population increased in the Southwest, there was a campaign against providing equitable education to Mexicans and Mexican Americans on the claims of the “anxiety” [1] that their presence created

on the Anglo population. This “anxiety” first led to the Spanish language being discouraged in school and eventually becoming banned through policies implemented by Anglos.

Anglos sought to perpetuate the idea that Mexican Americans were incapable of progressing academically due to inherent deficits in the community, the home, and – as described by Valencia [6] and MacDonald [10]– in the cultural heritage of Mexican Americans. San Miguel [1] argued that these efforts from Anglos to promote “Anglo cultural purity, unification of the nation through establishment of a common culture and a common language, and maintenance of White political dominance” (p. 43) was detrimental for the education of all Mexicans, Mexican Americans, Chicanos and Latinos/as/xs in the Southwest. While these events may have taken place decades ago and exacerbated during between the 1880’s and 1920’s, the current narrative in country continues to be the same. One of the most recent events is the elimination of bilingual education in lieu of a subtractive approach called Sheltered English Immersion through Proposition 203 in Arizona [11], and similar efforts to ban bilingual education in Texas, California and Washington.

This contextual and historical backdrop is important because it is only through this historical perspective that we can have a better idea of what needs to be revisited in engineering education research, and to demystify the problematic framing of Latinos/as/xs as a monolith [12-14]. While the research mentioned previously did not focus specifically on STEM education, the ramifications of this type of subtractive schooling [15] continues to impact the overall engineering education of Latinos/as/xs. Considering this historical legacy of education in the U.S. Southwest, we sought to collaborate with middle school teachers to infuse an asset-based perspective to the ways in which STEM education, and specifically engineering, was presented and taught to Latino/a/x emergent bilinguals. In this project we focused on how collaborations between interdisciplinary groups of researchers and middle school bilingual and dual language teachers led to using Funds of Knowledge [16] as a tool to engage in science and engineering teaching and learning. This collaboration was grounded on the principle that funds of knowledge can guide teachers to research and document knowledge of their own students, families and communities, its sociopolitical contexts, and integrate them into a bilingual and dual language classroom.

Theoretical Framework

Funds of knowledge research was intended to demonstrate that households provide the unique environment for learning “where error is not dealt with punitively and where self-esteem is not endangered” [17], as opposed to the formal classroom setting where ability and intellect of students are contested. Vélez-Ibáñez and Greenberg [17] explored how Mexican and Mexican American communities in the U.S. Southwest used their networks to exchange information that was important for their surviving and well-being. These activities included skills and practices that were relevant for thriving in their environmental surroundings, such as building water distribution systems to engage in agricultural activities in drought-prone areas of the Southwest

[17]. It is this knowledge that was transferred to children and through generations. Thus, the idea that students came into the classroom as empty vessels was challenged since their lived experiences constituted a repertoire of skills, knowledge and practices that were important even if these were not valued by teachers.

Thus, these sociopolitical forces (e.g., ideologies, policies, practices, and norms) serve as the backdrop for the ways in which power dynamics, where only certain ways of being are recognized in the classroom, certain types of knowledge are considered valid, and only some ways of doing are accepted. The study of Vélez-Ibáñez and Greenberg [17] provided the basis for researchers to investigate the ways in which knowledge, skills, and practices are communicated and transferred through home, familial, and community networks of exchange. Funds of knowledge then became a research approach in education that sought to frame these home, familial and community practices as assets while challenging deficit notions of Mexican and Mexican American students in the U.S. Southwest [18]. The initial purpose of funds of knowledge in education was to engage teachers in an inquiry process that would expose them to see how knowledge construction occurred outside of the bounds of the classroom [16, 19, 20]. Additionally, the goal of funds of knowledge research was to resist the idea that low-income Mexican and Mexican Americans students and their families carry inherent deficits that prevent their success in the classroom. It is this premise that we used for this project as we sought to engage middle school teachers with funds of knowledge as a tool that could engage in science and engineering teaching and learning.

Context of the Study

This paper is part of a larger study where we sought to provide eight middle school bilingual and dual language teachers at a STEM-based Title I school located in the U.S.-Mexico border with opportunities to co-create engineering activities that recognized, valued and elicited students' funds of knowledge. It is important to mention that even though there were 8 teachers at the beginning of the study, during the COVID-19 pandemic the school district went through different administrative changes and financial hardships that resulted in two of the teachers receiving pink slips, one teacher leaving the school district, and one teacher deciding to pursue graduate education. In the end, one teacher participated in this project for one year, two teachers participated for 2 years, one teacher participated for 3 years, and four teachers participated for 4 years during the project. It is also important to mention that the school received a large number of transfronterize students, 60% of the students received free/reduced lunch, 80% of the students were Latino/a/x, and 40% were classified as English Language Learners.

The research question that guided the analysis presented in this paper was: What strategies were most helpful in developing teachers' understanding and elicitation of funds of knowledge? In this paper, we focus on the lessons learned from the four teachers that were part of the project throughout the four years. The four teachers included one computer science/science teacher

(female, white), one bilingual mathematics teacher (female, Latina), one bilingual social science teacher (male, Latino), and one 7th grade Spanish teacher (female, Latina).

Methods and Preliminary Analysis

We collected data from classroom observations, teacher interviews, group discussions with the research team, and teacher meeting check-ins. For this paper, we focused on classroom observations and teacher interviews. The data collected were analyzed using inductive and deductive coding, starting with a list of a-priori codes [21]. Four members of the research team analyzed the data using Dedoose after agreement was reached on a singular coding scheme. Data suggests that teachers were already taking actions to elicit students' funds of knowledge in different ways, such as facilitating classroom discussions with prompts and scaffolds. In addition, teachers were reminded that language is an important fund of knowledge that should be considered as a fundamental part of learning STEAM-related content. The most helpful strategies included reading materials related to funds of knowledge, the professional development workshops, the one-on-one meetings with teachers, and the coaching strategies used by the research team. Overall, these strategies led to the use of role models, bringing their own personal experiences into STEAM teaching, using anecdotes, co-creating materials with researchers, and engaging in cross-disciplinary collaborations to recognize and elicit funds of knowledge. The results from this research suggest teachers can develop STEAM units or activities by observing and documenting the spaces, practices, and knowledge familiar to their students, particularly their U.S.-Mexico border experiences (i.e., transfronterize experiences).

Lessons Learned

All participating teachers developed their own engineering activity. Teachers highlighted language as an important fund of knowledge that should be considered as a fundamental part of learning STEM-related content. Also, teachers acknowledged students bring a wealth of knowledge, skills and practices that facilitate and mediate STEM learning. Preliminary data analysis indicated that funds of knowledge became a mediating tool for the teachers learning about the integration of language, funds of knowledge, and STEM content. Teachers embraced an approach to education where they acted as institutional agents that, despite the challenges faced, celebrated the ways of being, knowing and doing of their students.

One of the most significant results was that funds of knowledge guided teachers in questioning preconceived notions about what types of knowledge have a place in STEM. Funds of knowledge guided how teachers developed their units or activities by observing and documenting the spaces, practices, and knowledge familiar to their students, particularly their U.S.-Mexico border experiences. Teachers repeatedly acknowledged the borderland experiences of their students as important frames for learning of and about STEM.

We identified that empowering and establishing rapport with teachers was important for creating opportunities for teachers to reflect on their teaching practices. The teachers sought to create STEM learning opportunities that explicitly drew on students' funds of knowledge, specifically their home language practices (including translanguaging) and border-crossing experiences. The project also allowed teachers to create materials that could result in a sustained and equitable change in the educational experiences of working-class Latino/a/x in STEM learning. Finally, students constantly created ways to represent their identities and ways of being through the engineering activities, and reflected on the impacts of engineering design in their communities.

Significance

We argue that collaborative work grounded on funds of knowledge with middle school teachers is important to challenge deficit ideologies and to mediate science and engineering teaching and learning, particularly in bilingual and dual language contexts. Funds of knowledge also counters hegemonic practices and reflects educational practices that can lead to social change, including teachers and students taking on more agency about science and engineering work. Collaborations with teachers also have the potential to explore students' lives while recognizing its embedded sociopolitical contexts.

The strategies adopted for this project have created a positive impact on teachers' understanding of concepts such as engineering and funds of knowledge. The coaching strategy used during teacher check-ins, for example, also allowed for the creation of a space where linguistic diversity became the norm, sharing of ideas was welcomed, and co-creation of activities was fundamental. The research team endeavored to develop a relationship of reliance and trust (*confianza*) with the teachers, which was very important for the coaching relationship. For instance, we developed *confianza* by facilitating sessions in both English and Spanish. The teachers themselves were bilingual and we used that linguistic diversity to connect with them. Thus, modeling those interactions helped create *confianza* with teachers and contributed to how the teachers began to acknowledge language as an important fund of knowledge - something that was later reflected in the classroom.

Acknowledgements

This material is based upon work supported by the National Science Foundation under Grant No. 1826354 and 2211032. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the National Science Foundation.

References

- [1] G. J. San Miguel, "The schooling of Mexicanos in the Southwest 1848-1891," in *The elusive quest for equality : 150 years of Chicano/Chicana education*, J. F. Moreno Ed. Cambridge, MA: Harvard Educational Review, 1999, pp. 31-45.
- [2] G. J. San Miguel, " *Let All of Them Take Heed*": *Mexican Americans and the Campaign for Educational Equality in Texas, 1910-1981*. University of Texas Press, 1987.
- [3] G. J. San Miguel and R. Valencia, "From the Treaty of Guadalupe Hidalgo to Hopwood: The educational plight and struggle of Mexican Americans in the Southwest," *Harvard Educational Review*, vol. 68, no. 3, pp. 353-413, 1998.
- [4] R. R. Valencia, "Conceptualizing the notion of deficit thinking," *The evolution of deficit thinking: Educational thought and practice*, vol. 19, no. 1, pp. 1-12, 1997.
- [5] R. R. Valencia, *Dismantling contemporary deficit thinking: Educational thought and practice*. Routledge, 2010.
- [6] R. R. Valencia, "The plight of Chicano students: An overview of schooling conditions and outcomes," in *Chicano school failure and success: Past, present and future*, R. Valencia Ed. New York: Taylor & Francis Group, 2010, pp. 3-41.
- [7] J. Mejia, R. Revelo, I. Villanueva, and J. Mejia, "Critical Theoretical Frameworks in Engineering Education: An Anti-Deficit and Liberative Approach," *Education Sciences*, vol. 8, no. 4, 2018, doi: 10.3390/educsci8040158.
- [8] J. A. Mejia, A. Esquinca, V. Popov, M. Arana, M. Roberto, and N. Reyes, "Integrating Asset-based Practices, Engineering, and NGSS: Lessons from Working with Teachers through a Community-focused Approach," in *Proceedings of the 2020 American Society for Engineering Education (ASEE) Annual Conference*, 2020.
- [9] S. Secules and J. A. Mejia, "Contextualizing the past to guide the future: Situating three critical theoretical frameworks for educational culture," *Studies in Engineering Education*, vol. 1, no. 2, 2021.
- [10] V.-M. a. MacDonald, *Latino education in the United States : a narrated history from 1513-2000*, 1st ed. New York: Palgrave Macmillan, 2004.
- [11] E. J. Johnson and D. C. Johnson, "Language policy and bilingual education in Arizona and Washington state," *International Journal of Bilingual Education and Bilingualism*, vol. 18, no. 1, pp. 92-112, 2015.
- [12] R. A. Revelo, J. A. Mejia, and I. Villanueva, "Who are we? Beyond monolithic perspectives of latinxs in engineering," in *American Society for Engineering Education Annual Conference and Exposition*, Columbus, OH, 2017, vol. 2017.
- [13] R. A. Revelo and N. Stepin, "Within-Group Differences of Engineering Identity for Latinx Engineering Students," in *2018 IEEE Frontiers in Education Conference (FIE)*, San Jose, CA, 2018: IEEE, pp. 1-5.
- [14] I. Villanueva Alarcón, J. A. Mejia, J. Mejia, and R. Revelo, "Latiné, Latinx, Latina, Latino, or Hispanic: Problematizing terms often used in engineering education," *Journal of Engineering Education*, 2022.
- [15] A. Valenzuela, *Subtractive schooling: US-Mexican youth and the politics of caring*. Albany, NY: State University of New York Press, 2010.

- [16] L. C. Moll, C. Amanti, D. Neff, and N. Gonzalez, "Funds of knowledge for teaching: Using a qualitative approach to connect homes and classrooms," *Theory into practice*, vol. 31, no. 2, pp. 132-141, 1992.
- [17] C. G. Vélez-Ibáñez and J. B. Greenberg, "Formation and transformation of funds of knowledge among US-Mexican households," *Anthropology & Education Quarterly*, vol. 23, no. 4, pp. 313-335, 1992.
- [18] G. M. Rodriguez, "Power and agency in education: Exploring the pedagogical dimensions of funds of knowledge," *Review of Research in Education*, vol. 37, no. 1, pp. 87-120, 2013.
- [19] N. González, L. C. Moll, and C. Amanti, *Funds of knowledge: Theorizing practices in households, communities, and classrooms*. Mahwah, NJ: Lawrence Erlbaum, 2006.
- [20] N. González, L. Wyman, and B. H. O'Connor, Eds. *The past, present, and future of "funds of knowledge"* (A Companion to the Anthropology of Education. Malden, MA: Wiley-Blackwell, 2011, pp. 481-494.
- [21] J. Saldaña, *The coding manual for qualitative researchers*, 2nd ed. Thousand Oaks, CA: SAGE, 2015.