

## **Board 104: Asset-Based Practices in Engineering Design (APRENDE): Development of a Funds of Knowledge Approach for the Formation of Engineers**

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Dr. Joel Alejandro (Alex) Mejia is an assistant professor of Integrated Engineering at the University of San Diego. His current research investigates how the integration of funds of knowledge and engineering design can serve as a pathway to and through engineering. Dr. Mejia is particularly interested in how Latinx adolescents bring forth unique ways of knowing, doing, and being that provide them with particular ways of framing, approaching, and solving engineering problems. Dr. Mejia's primary research interests lie at the intersection of engineering education and social justice. He is particularly interested in the integration of Chicana Cultural Studies frameworks and pedagogies in engineering education, and critical consciousness in engineering through social justice.

### **Damian Ruiz, University of San Diego/San Diego State University**

Damian Ruiz is Assistant Director of the Cultural Proficiency Institute for Educators at San Diego State University's College of Extended Studies, where he designs and implements culturally responsive curriculum for current educators, institutions, and graduates. Damian is also Assistant Director of the Cultural Proficiency Minor at San Diego State University's College of Education, where he designs strengths-based, culturally responsive curriculum and counseling services for undergraduate students. Additionally, Damian is a Lecturer at San Diego State University for various Multicultural Education courses. His work is grounded in a social justice perspective to support equity-and inclusion-oriented initiatives in education. Damian is currently a graduate student participating in San Diego State University's Master's in Education Program specializing in Critical Literacy and Social Justice.

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Dr. Vitaliy Popov is the Associate Director of Research at the Jacobs Institute for Innovation in Education (JI) at the University of San Diego (USD), a research center named after Dr. Irwin and Joan Jacobs of Qualcomm that has a history in investigating best practices for technology in education. He has both a BA and MS in Education and Learning Sciences with a focus on engineering education, as well as a PhD in Educational Technology. For his dissertation, he looked at how technologies can foster cross-cultural collaboration for students from over 55 countries. Over the last eight years, he has presented and published papers on education and technology at AERA and in journals such as *Computers in Human Behavior*. Currently, he is serving as a co-principal investigator on two projects funded by the National Science Foundation (Awards #1826354 (RFE) and #1713547 (AISL)); one of these projects is developing a STEM summer camp that supports career pathways for Latinx students.

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# **Asset-Based Practices in Engineering Design (APRENDE): Development of a Funds of Knowledge Approach for the Formation of Engineers**

## **Abstract**

Although different scholars have offered several reasons behind why Latinx students do not pursue STEM careers—particularly engineering—many scholars have argued that one particularly powerful reason is that the cultures of students do not fit the dominant discourse of engineering. It has been argued that curriculum materials do not portray the lived experiences and embodied knowledge of students who come from non-White, non-English-speaking backgrounds. In addition, teacher preparation has been questioned regarding the opportunities available for teachers to identify with engineering and make the curriculum more culturally relevant to students. Building this capacity is critical for the recruitment, preparation and broader participation of underserved communities in STEM. Moreover, teacher preparation is necessary to dismantle the dominant narratives in STEM and to provide the space for underrepresented students' embodied knowledge to be acknowledged, valued, and integrated into the curriculum. This project presents the ongoing efforts to analyze how a more situated view of engineering, particularly through asset-based approaches, can serve as a pathway to and through engineering for Latinx students. The goal is to provide teachers with the tools to identify, elicit, and recognize students' funds of knowledge as assets in solving engineering problems.

## **Introduction**

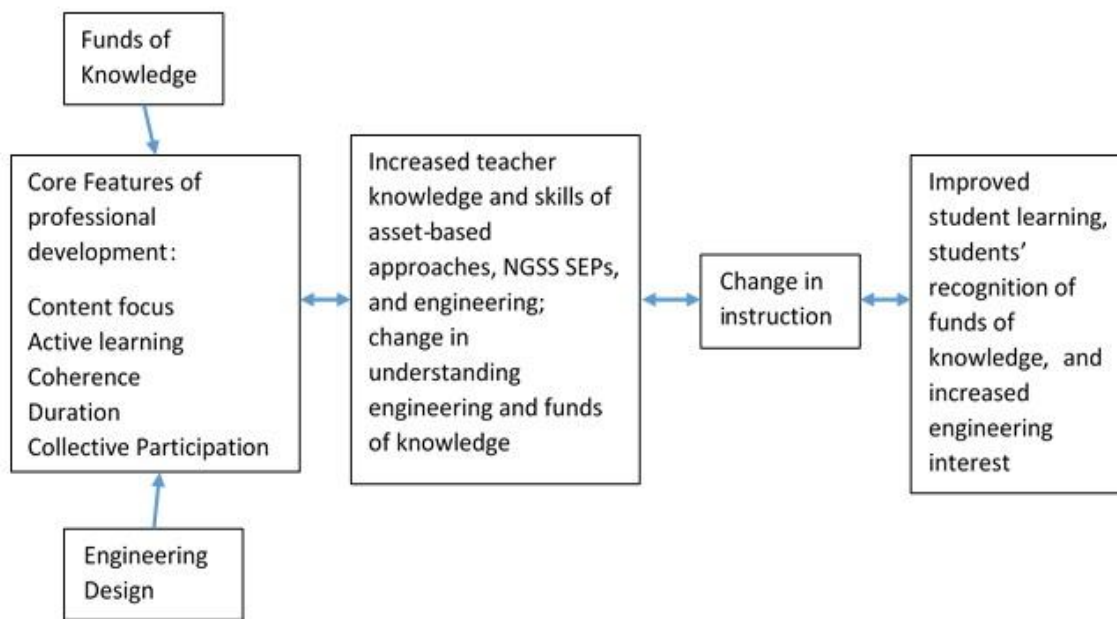
Funds of knowledge are historically accumulated and culturally developed bodies of cultural, social, historical and cognitive knowledge and skills that are essential for household and individual functioning and well-being. Using funds of knowledge in the classroom has been noted as an asset-based approach because students' assets are explored while deficit notions of students' abilities are challenged. Dolores Delgado-Bernal [1] argued that “although students of color are holders and creators of knowledge, they often feel as if their stories, experiences, cultures, and languages are devalued, misinterpreted, or omitted within formal educational settings” (p. 106). These perspectives have created a master narrative in engineering that disenfranchises students of color by delegitimizing their presence in engineering spaces. Creating spaces that foster the ways of knowing, doing, and being of underrepresented students is extremely important in making engineering more accessible and equitable. Unfortunately, the perception that engineering knowledge is non-existent in communities of color has perpetuated the idea that being "different" equals to "becoming at risk" in educational settings [2-5].

Emphasizing the holistic student perspective (i.e., their histories, social and economic backgrounds, language experiences, etc.) could situate engineering as a field that acknowledges that framing problems through a variety of perspectives and worldviews is not a “deficient” understanding of engineering. On the contrary, it recognizes that acknowledging unique perspectives on engineering is emancipatory for Latinx students that have been historically marginalized, as they can begin to see that “their complete personhood is never doubted” [6, p. 76]. Thus, engineering education must include engineering design activities that engage Latinx

adolescents through their own language and culture, which allows them to provide engineering solutions to and for their communities. Moreover, engineering learning could potentially be more effective when teachers—the immediate role models—gain an appreciation and understanding of students' embodied knowledge. We posit that becoming aware of funds of knowledge, eliciting those funds of knowledge, and applying those funds of knowledge to engineering design by both teachers and students produces beneficial outcomes that are beyond those associated only with understanding the engineering design process. The framework presented in this paper builds on prior evidence supporting the use of funds of knowledge and engineering design, as a STEM integrator, as well as empirical research on the structure, content, and outcomes of effective professional learning to create transformative educational experiences for teachers, and ultimately their students [7-10].

### The APRENDE Project

The Asset-based Practices in Engineering Design (APRENDE) project focuses on both middle school students and their teachers. It offers the opportunity to have an early impact on students' engineering interest while also providing teachers with a broader perspective of how to develop students' engineering habits of mind and dispositions using funds of knowledge. The goal of this three-year project is (1) to provide opportunities for teachers to develop an understanding of and appreciation for funds of knowledge, (2) to support them in integrating funds of knowledge into their engineering design class, and (3) to examine how such integration of funds of knowledge can impact Latinx students' and English Language Learners' interest in and knowledge of engineering. We posit that effective engineering learning happens when teachers blend funds of knowledge with the engineering design process. Figure 1 illustrates our focus on the intersection of engineering and funds of knowledge as it shapes engineering design learning.



**Figure 1.** Conceptual Framework of the *APRENDE Project* (adapted from Desimone [10]).

The basis of the study is to engage teachers in the co-design, with the project investigators, of different engineering design activities that integrate funds of knowledge of the students. This study is designed to develop teachers' understanding of funds of knowledge, emphasizing the role that it can play in the teaching of engineering design, and combine relevant practices of science and engineering. This study takes as its point of departure the understanding that funds of knowledge are crucial for the transformation of beliefs and attitudes toward engineering. When teachers are provided the opportunity to learn how to incorporate students' funds of knowledge into their practice, underrepresented minority students' knowledge and dispositions toward engineering can be enhanced. Desimone [10] argues that "there is a research consensus on the main features of professional development that have been associated with changes in knowledge, practice, and, to a lesser extent, student achievement" (p. 183). These features include: (1) a focus on subject matter content and how students learn that content; (2) opportunities for teachers to engage in active learning; (3) coherence, which includes consistency with both teacher knowledge and beliefs, and school, district, and state policies; (4) sufficient duration, in terms of number of hours and span of time; and (5) collective participation. The *APRENDE Project* professional development plan will address each of these five features using a research design that privileges problem solving through iterative stages of practice and reflection [11].

### **Pilot Study**

The first year of this study we conducted initial interviews with teachers who had previously participated in a summer camp with primarily Latinx middle school students. The summer camp involved 3 in-service teachers, 5 graduate students, and 8 undergraduate students working as STEM summer camp facilitators for 77 middle school students. The pilot study focused on the 3 in-service teachers as they navigated working with students in both formal and informal spaces. The goal of the pilot study was to generate some information of in-service teachers' perceptions of funds of knowledge and the strategies that teachers used in understanding and eliciting students' funds of knowledge. This pilot study served as the foundation for the research team to identify areas that would need to be emphasized during the duration of the APRENDE Project through a smaller-scale pilot.

The three teachers in the pilot study engaged in different STEM activities, including building simple chain reaction machines, explorations with circuits, and mathematical visualization through paper folding. The teachers went through a one-week training where they learned how to facilitate the activities during the STEM summer camp and were briefly introduced to the concept of funds of knowledge. At the conclusion of the STEM summer camp, the in-service teachers were interviewed and asked to reflect about their experience in the STEM summer camp. Each interview was audio-recorded and lasted approximately 45 minutes. Audio recordings were later transcribed and coded by Authors 1 and 2 following a deductive coding approach [12].

### **Preliminary Results**

During the interviews we asked teachers what the concept of funds of knowledge is, how they elicited their students' funds of knowledge, and the benefits of bringing funds of knowledge to

the forefront of STEM learning. Surprisingly, even though teachers were given a brief introduction to funds of knowledge, they continued to perceive funds of knowledge as prior knowledge. Opposite to prior knowledge, funds of knowledge are situated in communities and their collective stories, are communal and historic, and are rooted in materialism (as families used their funds of knowledge to cover their material needs) [13,14]. Unfortunately, this perception continues to be a misunderstanding of the knowledge that is contained within communities and households and that continues to be devalued in formal spaces. This lack of understanding could be attributed to both the content of the summer program and its alignment to normative narratives of engineering practices, and also to the time constraints and lack of tools, primarily the time the teachers were exposed to how to elicit funds of knowledge. Nonetheless, the teachers indicated the importance of building bridges between both formal and informal learning as well as the impact of those connections on student success.

Teachers mentioned that eliciting funds of knowledge was facilitated when the students were able to find something that was relatable and familiar. Nonetheless, time provided for reflection during the summer camp was not enough and some of the students soon forgot about such connections. In addition, the teachers emphasized the importance of meeting the students where they are in order to really understand the wealth of the knowledge that comes from home and the community. For example, some of the activities did not allow for time to reflect with the students on how to make meaningful connections on the spot. Some of the teachers indicated that some strategies were helpful to at least get them started in doing a paradigm shift. For instance, they mentioned that sharing stories with the students, asking questions, validating experiences, informal conversations with parents, and becoming the student (e.g., immersing in the activities that the students engage in) are key practices that should be emphasized in classrooms to make STEM more meaningful for students, and for students to see themselves reflected in the curriculum.

## **Future Work**

Our current work seeks to expand what was done during the STEM summer camp and work with teachers in the neighboring school district. We have selected 9 middle school teachers across different subject areas (language arts, science, mathematics, and bilingual education) to participate in this three-year project. As we move into Year 2 of the project, we will seek the advice of experts in ethnic studies, engineering, and teacher education to ensure that the teacher preparation model and engineering activities developed with the teachers address the objectives of the project. We continue to formulate a better understanding of funds of knowledge in engineering and the potential for STEM learning transformation. Data collected from this project will be used to identify how participation in the APRENDE Project impacts teachers' understanding of funds of knowledge and how these can be aligned to engineering design processes, habits of mind, and dispositions. The data will be collected as the teachers work with the research team in co-constructing engineering activities and subsequent implementation in their classrooms.

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