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Territorializing routines of action in the science classroom: Preservice Teachers Using Engineering and Culturally Sustaining Pedagogies in Elementary Grades

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Abstract

As part of Next Generation of Science Standards (NGSS), in-service and pre-service teachers must become familiar with and learn to plan and implement engineering activities using one of the available engineering design models. In addition, pre-service teachers must teach this content to a growing multilingual students in elementary grades in the US. In this presentation, we describe how pre-service teachers use a modified 7-step engineering model to teach about sound to a group of rising 4th grade emergent bilingual students in a summer program in English and Spanish. Using the process of territorialization from assemblage theory, we explore how three pre-service teachers implemented engineering activities using culturally and linguistically sustaining pedagogies. We conclude with a series of recommendations to facilitate the process of territorialization for pre-service teachers in science/engineering education.

1. *Purpose*

Over the past decade, reform initiatives in science and engineering education (Achieve, 2013; NRC, 2012) have been paralleled by the need for new science and engineering skills in the industrial sector (Gordon & DeBard, 2014). However, there are two areas that need to be addressed for this to happen in pre-service teacher education: 1) Pre-service teachers in elementary education need to learn about and take ownership on how to plan and implement engineering activities in the classroom, and 2) pre-service teachers need to learn how to use culturally and linguistically sustaining pedagogies (CLSP) to address the needs of the growing multilingual and multicultural student population.

In this presentation, we argue for a 7-step engineering model based on developing problem solving skills and the use of science to facilitate the pre-service teaching of science content in elementary grades. Moreover, we delve into the incorporation of science and engineering models by integrating culturally and linguistically sustaining pedagogies, aiming to support to the emergent bilingual student population. Our hypothesis is that using the 7-step engineering model and the CLSP will help preservice teachers to territorialize these practices to teach about sound to a group of 4th grade emergent bilingual students.

2. *Theoretical framework - Assemblage theory*

Drawing from De Landa (De Landa, 2002, 2006, 2011) and the readings he does from Deleuze and Guattari's work (1987) we use assemblage theory to experiment and make sense of the connections between the diverse elements and processes in this landscape: pre-service teachers, emergent bilingual Latine students, science and engineering, English and Spanish, among other things. Assemblage theory in this regard help elucidating each of the elements combined in this landscape as well as the processes involved because an assemblage "denotes an arrangement resulting from a combination of elements, as well as the action or manner of assembling or combining" (Bogue, 1989, p. 174). He will later add that these heterogeneous collections of actions and entities "somehow function together" (Bogue, 2007, p. 20). De Landa (2006) notes that assemblages consist of two different dimensions: the expressive-material axis and the territorialization-deterritorialization axis. Both dimensions are particularly important for science education: The material-expressive axis defines the different roles of the elements in the assemblage, that in our case include what students, including Emergent Bilingual Learners, as well as the science educational contexts where they have to work on developing language skills (e.g., reading, writing, and communicating) along with understanding, manipulating, and experimenting with science materials (e.g., bodies, realia). The territorialization-deterritorialization dimension helps us understand and elucidate the processes in which these elements participate, that is, how preservice teachers explore the use of culturally and linguistically sustaining pedagogies to teach engineering and sound in a summer program.

Assemblage theory emphasizes experimentation to find critical thresholds that in our case are localized by connecting the culturally and linguistically sustaining pedagogies with Latine students that in our case lead to a different engineering learning environment.

3. Methods

We use a sociohistorical process approach to understand the importance of the language spoken at home as well as the culture in forming the emergent bilingual Latine student identity for each of the participants after collecting data using a survey and conversations with parents/guardian before the summer program. Then, we use a combination of funds of knowledge (González, Moll, & Amanti, 2005) and assemblage theory (De Landa, 2006; Deleuze & Guattari, 1987) to connect the science/engineering content and skills to cultural practices and the use of Spanish and English. The engineering activities about sound were constructed following the 7-step engineering design model that consists of the following steps: ask, research the problem, imagine and plan, create the prototype and explain the concepts, test the prototype, improve the prototype, and communicate results. In addition, we interview the student participants at the beginning and end of this research about their personal stories in relation to science and soccer interests as well as their participation in this program.

These culturally and linguistically sustaining activities address the following overarching question: (a) How do preservice teachers use a culturally and linguistically sustaining approach to teach emerging bilingual Latine students engineering activities

about sound? And we complement it with secondary questions such as: (b) How do emerging bilingual Latine students solve engineering problems about sound? (c) In what ways can we develop these culturally and linguistically practices addressing a broader student population?

4. Data sources

Data were gathered from one engineering lesson plan with 7-steps with their corresponding activities with twelve students over 7 days of instruction. Each day had one section of 80 minutes of engineering activities. Working with the three preservice teachers, students used these activities to learn about sound while constructing, testing, and improving a prototype to solve a problem. At the end, students presented their findings to an audience.

In addition, we gathered initial and final information from three preservice teachers using a semi structured interview that we used to record to study the process of planning, implementing, and evaluating the lesson plans and activities to understand how they made sense of using culturally and linguistically sustaining practices to teach engineering to emergent bilingual students.

The ethnic composition of the rising 4^{th} grade classroom was: Twenty-one students of Latino descent. Preservice teacher demographics were: two white preservice teachers and one Latina preservice teacher. Materials were prepared in English and Spanish, and students were welcomed to work individually or with partners to complete the engineering activities. Students were encouraged throughout to use English, Spanish, or a combination of both languages to communicate their ideas, findings and/or descriptions.

5. Results and Significance of the Study

In this research, data show that when preservice teachers are exposed to culturally and linguistically sustaining pedagogies in engineering, they are better prepared to plan and implement meaningful engineering lesson plans for their emergent bilingual students in the classroom. English monolingual preservice teachers used technology (e.g., office 356, Google translate) to communicate with students who recently arrived to the United States and who spoke Spanish. The integration of technology not only enhanced their classroom interactions but also fostered a warm and inviting atmosphere for learning.

For the engineering 7-step model, we found that the steps followed an efficient structure to engage students in understanding the context, elucidating the problem, brainstorming ideas to fix the problem, planning and evaluating the prototype, and, at the end, students communicated their findings to the public using bilingual poster presentations, prototypes, and bilingual flyers.

This research shows that preservice teachers using Latine students' culture and language have the potential to be used as an educational resource for teachers of engineering whose classrooms are experiencing a cultural and linguistic transformation. The *engineering connected with culturally and linguistically sustaining* activities helped the preservice teachers in this study to use a different educational structure that promoted problem solving skills as well as bilingual usage of the language of science in the context of a culturally meaningful activity. Assemblage theory provided the tools to conceptualize engineering as a catalyst for science learning for these Latine students.

More research is needed to explore how preservice teachers can plan and implement the engineering model and the CLSP during the regular school year where the schedule is not that flexible.

References