Analyzing the Cultural Responsiveness of Two Mathematics Units

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This paper describes a project presentation on the application of an analytical tool to assess the cultural responsiveness of two mathematical units developed in a bilingual mathematics club. Results provide initial considerations to assess culturally responsive mathematical tasks. Future steps and implications are discussed.

In this session we will discuss an on-going project that investigates Culturally Responsive Mathematics Learning Contexts (CRMLCs). Specifically, we explore the curricular features to design and establish CRMLCs in out-of-school settings with bilingual Latina/o students in the United States.

Setting

The out-of-school program, *Los Rayos* mathematics club, brought together bilingual Latina/o undergraduate students (mostly pre-service teachers, henceforth referred to as PSTs), Latina/o elementary students, and Spanish-speaking mothers to work collaboratively on open-ended mathematics tasks that required students to experiment, develop multiple strategies, and communicate their reasoning. This program, created through the Center for the Mathematics Education of Latinas/os (CEMELA), was designed to investigate the linguistic and cultural resources bilingual Latina/o students use and that support their mathematics learning. We focus our investigation in a time period during which noticeable shifts were documented in student engagement, language use, and ways in which PSTs used students' culture as an instructional resource.

During the first half of this time period, the curriculum included a collection of adapted mathematical tasks that emphasized problem solving and included non-routine problems that focused on topics such as fractions, logic, geometry, patterns, etc. The tasks did not build on one another. They were grouped by topic and were placed in binders, so everyone referred to them as the "binder activities." Student groups, each with a PST as facilitator, chose the tasks to work on in each session. On the second half of this time period, however, the context and content of the mathematical activities changed. This time, all students were invited to work on the same project, whose mathematical goal was to support children's proportional reasoning. This project, which participants came to refer to as the "recipes project," consisted of sequenced activities designed to ultimately lead each group to create a recipe and prepare a dish for *Los Rayos'* end-of-year party. Project activities involved measuring and creating orange juice combinations, students reasoned and described why some combinations tasted more orangey; making mole with a group of mothers who posed mathematical problems in the process; creating a perfect recipe that each group chose; developing a budget and buying recipe ingredients at a local grocery store; scaling up the perfect recipe to serve all participants in the party; and finally making the dish for the party.

The two distinct activities mentioned above could be considered as discrete mathematical units since the topics and goals of each aimed at the understanding of different topics. Though both units were enacted at the same educational environment or physical space, the quality of student and PSTs' participation greatly varied between the two units. As mentioned earlier, several shifts were documented in each period. A major documented shift was the participants' language use. Specifically, during the binder activities, participants used predominantly English while in the recipes project, they predominantly used Spanish (Vomvoridi-Ivanovic, 2009). Another documented shift was the ways in which PSTs used cultural references as an instructional resource. Specifically, when working on the binder activities, PSTs alluded to cultural references only in non-mathematical contexts, while in the recipes project culture was used as a resource in mathematical contexts (Vomvoridi-Ivanovic, 2012). Finally, another shift included students' mathematical engagement.

Student engagement in recipes project was analyzed on how student proportional reasoning was supported. Results yielded that

student reasoning and engagement were enriched through multiple relations. These relationships were initially constructed through social and cultural dimensions, but they intensified over time into a mathematical dimension. The mathematical engagement was essentially relational. All participants' roles were transformed simultaneously though the design, preparation, and enlargement of the original recipes; proportional reasoning was simply part of the activity (Domínguez, LópezLeiva, & Khisty, 2014).

Overall the point that has captured our attention the most is the increased use of Spanish in mathematical activity during the recipes project. This shift in language use is an indicator of a learning context that apparently was more culturally responsive than the one in the binder activities. Here we investigate the ways in which the recipes project promoted a more culturally-responsive, mathematics-learning context.

Framework

Cultural responsive mathematics teaching includes teachers' understanding of the socio-political context of the teaching and learning in their classroom (Aguirre & Zavala, 2013). The inclusion of culturally responsive approaches deems family activities as mathematical resources available to students and teachers to support mathematics learning (Civil, 2007), and community practices can be leveraged to help contextualize and extend student mathematical understanding (Díez-Palomar, Simic-Muller, & Varley, 2007). In addition, this culturally responsive approach also capitalizes on authentic problem-solving contexts (Turner & Strawhun, 2007).

Methods and Findings

In order to investigate learning contexts culturally responsiveness, we chose to use the Culturally Responsive Mathematics Teaching (CRMT) Lesson Analysis Tool created by the TEACH math project (Aguirre, Drake, Bartell, Foote, McDuffie, & Turner (2012); (http://www.mathconnect.hs.iastate.edu/Instruments.html). This analytical tool is designed for professional development purposes so as

to support lesson/unit design and implementation with equity and power dimensions in mind. For this study, we used this tool to analyze a small subset of our data. Specifically, we analyzed four videos that captured *Los Rayos* group's interactions during two sessions in both the binder activities and the recipes project. Our findings confirm greater cultural responsiveness for the recipes project.

Although we found the CRMT Lesson Analysis tool to be useful in distinguishing between the two units (binders and family recipes), there are some areas in which the descriptors included in this tool seem limiting to capture the differences in richness of the experience that students had during each unit. For example, in both analysed sessions of the recipes unit, there is a kind of engagement, or student enthusiasm, that the descriptors included in the tool seem to fall short in capturing. It is not only about the fair and distributed participation, but also about the quality of participation which the CRMT tool seems unable to fully capture, despite earning full points according to the description provided in the rubric. Perhaps, an explanation for this limitation is that *participation* is a concept that implies a situated task or activity, and evaluating participation independently from its context seems counterproductive.

Another issue we found regards the tool's category five: academic language support for ELLs. As is the case with most classrooms (the intended context of the CRMT tool), there is emphasis on English as *the* mathematical language. The fact of including "different representations" does not acknowledge explicitly the use of other languages, which is evident in the case of the *Los Rayos* students, especially during the recipes unit. Multimodality could be used during instruction in any language to build understanding, but the explicit acknowledgement of the use of another language reflects not only other resources to understand mathematics, but also the inclusion of other practices and identities in mathematics.

Regarding categories 2 and 3 (depth of mathematical knowledge and mathematical discourse, respectively), our analysis highlights that the quality of mathematical discourse and the kind of reasoning that students experience during the two units is not only different in quantity, but in quality. For example, in recipes unit, we see a mathematical reasoning built on through social interactions and linked ideas over time. These provide a robustness of mathematical understanding that is not evident in the binders unit. In the binders unit, the short

engagement with the task seems to provide a level of reasoning that is transitory and irrelevant to the collective of the working team. In the recipe unit, the reasoning and mathematical actions of one person matter to the collective because it is connected to the collective. This takes the quality of mathematical discourse to a different level, as the interactions and exchanges seem to be more functionally and socially purposeful than in the binders unit. Thus, the complexity of the mathematical reasoning and discourse is also social, not only mathematical. Here is when the description included in the CRMT analytical tool, "students' reasoning, explanations, and arguments demonstrate fullness and complexity of understanding," seems arbitrary in, and vague around, what the "fullness and complexity" of knowledge and understanding mean.

During the session, we will present examples of our analysis using the proposed tool. Our goal is to engage the audience in thinking and conversing about the subtleties of designing and implementing culturally responsive mathematical tasks for unique contexts, and ways to capture the depth of particular practices and curricular designs.

Notes

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References

Aguirre, J. M., Drake, C., Bartell, T. G., Foote, M. Q., Roth McDuffie, A. & Turner, E. E. (2012). *Culturally Responsive Mathematics Teaching–Lesson Analysis Tool.* Teachers Empowered To Advance Change in Mathematics Project. Unpublished Instrument.

Aguirre, J. M., & Zavala, M. R. (2013). Making culturally responsive mathematics teaching explicit: A lesson analysis tool. P*edagogies: An International Journal, 8*(2), 163-190.

Civil, M. (2007). Building on community knowledge: An avenue to equity in mathematics education. In N. Nasir & P. Cobb (Eds.), *Improving access to mathematics: Diversity and equity in the classroom* (pp. 105-117). New York: Teachers College Press.

Díez-Palomar, J., Simic-Muller, K., & Varley, M.. (2007). El club de matemáticas. Una experiencia cultural de matemáticas de la vida cotidiana, para la diverisdad. *UNO, Revista de Didáctica de las Matemáticas, 45*.

Domínguez, H., LópezLeiva, C. A., & Khisty, L. L. (2014). Relational engagement: Proportional reasoning with bilingual Latino/a students. *Educational Studies in Mathematics, 85*(1), 143-160.

Turner, E. E., & Strawhun, B. T. (2007). Posing problems that matter: Investigating school overcrowding. *Teaching Children Mathematics, 13*(9), 457-463.

Vomvoridi-Ivanović, E. (2009). *Latina/o pre-service teachers' use of language and culture while assisting children in mathematics.* Unpublished dissertation. University of Illinois at Chicago.

Vomvoridi-Ivanović, E. (2012). Using culture as a resource in mathematics: The case of four Mexican American prospective teachers in a bilingual after-School program. *Journal of Mathematics Teacher Education, 15,* 53-66.