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Implementing Mathematical Modeling for Emergent Bilinguals

Abstract

In this study, a researcher collaborated with a middle school mathematics teacher through co-planning, teaching and reflecting upon mathematical modeling lessons to support emergent bilinguals to make sense of mathematics. We investigate how this collaboration impacts the process of co-teaching and co-planning in terms of the interactions between the researcher and the teacher. Our analysis reveals how each role changed and maintained during the collaboration and what factors were discussed to develop and implement modeling-based lessons for emergent bilinguals.

Keywords

Emergent bilinguals, mathematical modeling, modeling based lesson, co-teaching

Disciplines

Bilingual, Multilingual, and Multicultural Education | Curriculum and Instruction | Educational Methods | Science and Mathematics Education | Teacher Education and Professional Development

Comments

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IMPLEMENTING MATHEMATICAL MODELING FOR EMERGENT BILNGUALS

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In this study, a researcher collaborated with a middle school mathematics teacher through co-planning, teaching and reflecting upon mathematical modeling lessons to support emergent bilinguals to make sense of mathematics. We investigate how this collaboration impacts the process of co-teaching and co-planning in terms of the interactions between the researcher and the teacher. Our analysis reveals how each role changed and maintained during the collaboration and what factors were discussed to develop and implement modeling-based lessons for emergent bilinguals.

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Purpose of the Study

The purpose of this research was to develop and implement mathematical modeling curriculum that effectively connects to Emergent Bilinguals (EBs; a.k.a. English language learners) through a teacher-researcher collaboration. The project originated from the misconception, yet another myth, that it is not appropriate to provide rigorous mathematics or word problems to EBs due to their English proficiency (Reeves, 2006). If EBs receive only easy tasks by this misconception, they would not have an opportunity to engage in problem-solving that cultivate a deeper understanding in high-level mathematics. Moreover, researchers (e.g., Chval & Chavez, 2011) have recommended making connections between mathematics and EBs' life experience to make sense of mathematics problems. In order to respond to these demands and recommendations, we designed this project between a teacher and a researcher in the co-development and co-teaching of mathematics lessons based on modeling problems that incorporate EBs' real-world contexts. The research question is: "How do teacher and researcher make decisions for developing and implementing a mathematics curriculum in a way of supporting EBs to make sense of mathematical modeling?"

Perspectives

Mathematical Modeling

Principles to Actions (National Council of Teachers of Mathematics, 2014) states an excellent mathematics program requires all students to have access to a high-quality mathematics curriculum and high expectations. Thus, we chose to use mathematical modeling tasks because they require students to do cognitively demanding activities and involve a real-world context that is related to students' cultural and life experiences. Mathematical modeling is also included in the standards of mathematical practice of the Common Core State Standards for Mathematics (NGA Center & CCSSO, 2010). Anhalt (2014) argued a well-designed mathematical modeling problem can engage EBs due to the real-world connection and the insufficiency of given information is necessary because a real-life problem does not provide all necessary information unlike a textbook word problem. This perception is echoed in how Dan Meyer created 3-act tasks that introduce a real-life story contacting conflict that does not include all necessary information and requires students to identify and search for the missing parameters. Meyer (2011) explained each step of the 3-act task: Act 1 is to identify the central conflict of a real-world story; Act 2 is to look for resources and develop new tools; and Act 3 is to resolve the conflict and set up an

extension. We claim that it is necessary to add one more step when working with EBs because they may need further information to make sense of the story in Act 1. Therefore, the four actions are: (1) Make sense of the real-life story, (2) Identify the problem in the story, (3) Build a strategy and gather information, and (4) Resolve the problem and look for extension.

Design-based Research

The collaboration of a teacher and a researcher plays a crucial role in this project because their expertise complement each another's needs and build off the other's strengths. Hence, we employ multi-tier design-based research (DBR; Brown, 1992; Cobb, Confrey, Lehrer, & Schauble, 2003) in order to build an effective relationship among a researcher, a teacher, and also students. In this multi-tiered teaching experiment, a teacher acts as a researcher and teacher, and a researcher acts as a teacher, a learner and as an investigator, as they co-develop, co-teach, and analyze the lessons together (Jung & Brady, 2016).

Methods

Context and Participants

This project was conducted in one mathematics classroom in an urban middle school with 76.4% students of free and reduced lunch and 28.4% EBs, including many refugee students. There are more than 100 languages spoken in this district. There were 11 EBs in grades 7 and 8, consisting of 6 female and 5 male students in the EB-specialized mathematics class. The teacher had both mathematics (grades 5-12) and ELL (K-12) endorsement. She had 3 years of teaching experience when this project began and English monolingual. All EBs stayed in the U.S. within two years and their mathematics and English proficiency levels varied, but all scored 0 (lowest level) on the initial English language proficiency assessment conducted by the school district. Among 11 students, there were 3 Spanish speakers, 3 Swahili speakers, 2 Arabic speakers, 2 Burmese speakers, and 1 Karenni speaker.

Data Collection and Analysis

Applying the DBR collaborative research design, the researcher and the teacher met regularly for approximately one semester to co-develop modeling lessons and co-teach the lessons. All meetings were audiotaped, and the classroom teachings were videotaped. In every teaching session, the students were asked to write their work and reflect on their learning experience in a written form. The cycle for one lesson took two weeks: lesson planning in 1st week and teaching in 2nd week. After the 12 weeks, we interviewed five students about their experience and learning as well as an exit survey for the teacher. The data was analyzed qualitatively. Audio recordings and video recordings were transcribed when needed. The research team read all data multiple times and conduct open-coding (Strauss & Corbin, 1990) focusing on the research question. First, each coder identified the decision-making points in co-planning sessions and debriefings and examined who initiated each decision-making process because we believe the one who initiated a conversation with a new topic has a leading role. Based on the results of coding, codebook (Saldaña, 2013) was drafted, constructed by several generalizing and merging codes through several discussions. Then, a map of codes connecting them through phases such as planning, implementation, and debriefing was made to see how each decision-making impacts the following procedures of teaching. In addition, we investigated how the decision-making topics are repeated and addressed differently as time evolves. The multiple sources of data were triangulated.

Results

From the map with the topic of decision-making points during planning and debriefing

sessions as well as teaching sessions, we identified the topics that appeared often and repeated in many sessions although the mathematical concepts and the tasks implemented were different. The topics we found in all lessons were how to group students and how to have students share their solutions. The topics we found in four or five weeks were task/context selection, making guiding questions for each Act, including the names students are familiar with in the story problem, assessing students' vocabulary understanding, using objects/manipulatives, timing for each Act, and integrating students' life experiences in the problems.

We found that most topics addressed in planning phases appeared in the following teaching phases but there was some variation. For example, assessing students' understanding of the words embedded in the modeling problems were often discussed and planned how to help students learn those words. These plans were usually executed during teaching phases. In contrast, the plans about writing did not go as planned, especially during the beginning lessons. In the first lesson, the EBs took a long time to write their reflection so we had to postpone the closing of the lesson with completing the writing. Based on reflecting on this factor during debrief, the student's reflection journal form was modified several times to make it more open-ended and provide more guidance. Grouping students was another topic that was discussed in all lessons. Same language speaker groups were used in the first lesson and mixed-level groups were used in the second lesson based on observation of student-student interactions during the first lesson result. After these two weeks, students chose their groups until the last lesson because this group choice seemed to make the EBs work more comfortably. Similar to grouping students, having students share their solution was found in each lesson. However, like writing a reflection journal, implementing this plan was challenging due to time constraints because EBs needed an additional time to solve the problems. After having this challenge a few times, a decision was made to have student's presentation in the beginning part of the lesson to share their process earlier opposed to waiting for EBs to find their solutions. We inferred the high frequency of some topics reveals its importance in terms of teaching mathematics for EBs.

Discussion

Our results demonstrate the teacher-researcher collaboration model allows both the researcher and the teacher to participate in and contribute to lesson planning. The repeated topic analysis showed what the researcher and the teacher consider important factors of developing effective lessons for EBs. We found the majority of repeated topics concentrated on Act 1: Make sense of the real-life story and Act 4: Resolve the problem and look for extension. Act 4 also includes students' sharing of their solutions and Act 1 is one of the reasons why modeling is an effective way to teach EBs mathematics (Anhalt, 2014). This result is well aligned with what the teacher explained in the exit survey.

ELs [EBs] need digestible bites, especially on new concepts. I think the most important steps were Act 1 and Act 4. Without background knowledge, students do not have a platform to build off of. With ELs [EBs], I believe you can make no assumptions of what they already know. Act 4 ties all of the language and mathematical reasoning together to one final concept. In Act 4, students share out their reasoning and final answers as a group. They are also given an extension problem to go above and beyond the concept we had planned for the day. At the very end, students reflect on what they learned throughout the lesson through pictures or sentences in English or their native language. This ensures students are on the same page as they leave class that day.

We found one crucial factor from the discussion around timing. Timing was the one

particularly discussed in the beginning lesson planning. The main topic about timing was how much we should invest for Act 1 because it seemed this step sometimes needed a large portion of the entire lesson period. The goal of Act 1 was to provide contextual clues (Cummins, 2000), connect with students' life experience (Aguirre et al., 2013), and support students' understanding of words embedded in the main problem before the problem is given. The researcher and the teacher discussed how many minutes they should plan for this step and decided to set sufficient time and agreed to extend the time if needed with the belief that it would take a longer time if the EBs do not fully understand the problem (Jackson, Garrison, Wilson, Gibbons, & Shahan, 2013). Once EBs understand the problem, the rest of the procedures can be accelerated. We found the researcher-teacher collaboration model sheds light on the important factors to design a lesson for EBs and this can be an effective form of teacher professional development.

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References

- Aguirre, J. M., Turner, E. E., Bartell, T. G., Kalinec-Craig, C., Foote, M. Q., Roth McDuffie, A., & Drake, C. (2013). Making connections in practice: How prospective elementary teachers connect to children's mathematical thinking and community funds of knowledge in mathematics instruction. *Journal of Teacher Education, 64*(2), 178–192. <https://doi.org/10.1177/0022487112466900>
- Anhalt, C. O. (2014). Scaffolding in mathematical modeling for ELLs. In *Common Core State Standards in Mathematics for English language learners* (pp. 111–126). Alexandria, VA: TESOL International Association.
- Brown, A. L. (1992). Design experiments: Theoretical and methodological challenges in creating complex interventions in classroom settings. *The Journal of the Learning Sciences, 2*(2), 141–178.
- Chval, K. B., & Chavez, O. (2011). Designing math lessons for English language learners. *Mathematics Teaching in the Middle School, 17*(5), 261–265.
- Cobb, P., Confrey, J., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9–13.
- Cummins, J. (2000). *Language, power, and pedagogy bilingual children in the crossfire*. Tonawanda, NY: Multilingual Matters Ltd. Retrieved from <http://search.ebscohost.com/login.aspx?direct=true&scope=site&db=nlebk&db=nlabk&AN=80547>
- Jackson, K., Garrison, A., Wilson, J., Gibbons, L., & Shahan, E. (2013). Exploring relationships between setting up complex tasks and opportunities to learn in concluding whole-class discussions in middle-grades mathematics instruction. *Journal for Research in Mathematics Education, 44*(4), 646–682. <https://doi.org/10.5951/jresmetheduc.44.4.0646>
- Jung, H., & Brady, C. (2016). Roles of a teacher and researcher during in situ professional development around the implementation of mathematical modeling tasks. *Journal of Mathematics Teacher Education, 19*(2–3), 277–295. <https://doi.org/10.1007/s10857-015-9335-6>
- Meyer, D. (2011, May 11). The three acts of a mathematical story. Retrieved from <http://blog.mrmeyer.com/2011/the-three-acts-of-a-mathematical-story/>
- National Council of Teachers of Mathematics. (2014). *Principles to actions: ensuring mathematical success for all*. Reston, VA: The National Council of Teachers of Mathematics, Inc.
- National Governors Association Center for Best Practices, & Council of Chief State School Officers. (2010). *Common core state standards for mathematics*. Washington D.C.: National Governors Association Center for Best Practices, Council of Chief State School Officers. Washington, D.C.
- Reeves, J. (2006). Secondary teacher attitudes toward including English-language learners in mainstream