JOURNAL OF MATHEMATICS EDUCATION AT TEACHERS COLLEGE

A Century of Leadership in Mathematics and Its Teaching

Fostering Positive Cognitive and Affective Growth

TABLE OF CONTENTS

JOURNAL OF **MATHEMATICS EDUCATION** AT TEACHERS COLLEGE | FALL 2018 | VOLUME 9, ISSUE 2

TEACHERS COLLEGE | COLUMBIA UNIVERSITY

Community Super Investigators (CSI) Club: Mathematics and Literacy in Action

Brittany Slayton
University of Kentucky

Susana Salazar Velez
University of Kentucky

Cindy Jong
University of Kentucky

Kristen Perry
University of Kentucky

ABSTRACT This paper describes an after-school club aimed to engage elementary students in project-based learning by integrating mathematics and literacy connections within a community-based topic. Building on students' backgrounds and interests, researchers created the Community Super Investigators (CSI) Club as part of an after-school program to explore students' questions by using critical mathematics and literacy skills. Fourth and fifth grade students who participated in the CSI Club chose the topic of improving the lives of homeless animals in the community. The students' main goals were to promote the adoption of animals and lead a donation drive for the local humane society. Students were engaged because it was a topic of their interest, they had choices, and they had the opportunity to collaborate on authentic tasks. Mathematics and literacy connections were made by using iPads to research questions, documenting data and reflecting in journals, and making the content relevant with the community connection. Recommendations for improving after-school club experiences and making the content more critical are also provided.

KEYWORDS *mathematics and literacy connections, community, after-school, project-based learning*

Introduction

Project-based learning (PBL) is a teaching approach used to improve critical thinking skills and connect content to topics of interest to students (Bell, 2010). In particular, PBL has been used when teaching mathematics, literacy, and science concepts (Domino, 2009; Khisty & Chval, 2002; Krajcik & Blumenfeld, 2006). PBL can be a powerful tool for engaging students in meaningful learning experiences and making community connections (Khisty & Chval, 2002). There is limited research on using PBL to integrate mathematics and literacy for civic and community engagement, yet it has been shown to have the potential to empower students to make meaningful contributions and connections (Powell, Cantrell, & Adams, 2001; Turner, Gutiérrez, Simic-Muller, & Díez-Palomar, 2009). In after-school programs, PBL can also be a vehicle for students to explore topics of interest in more authentic ways due to the informal learning context (Noam, 2003).

Our project aimed to engage elementary students in project-based learning by integrating mathematics and literacy connections within a community-based topic. Building on students' backgrounds and interests, researchers created the Community Super Investigators (CSI) Club as part of an after-school program to explore students' questions by using critical mathematics and literacy skills. Critical mathematics and literacy draw on the Freirean notion that knowledge can be a powerful tool for liberation and social change (Frankenstein, 1983). Fourth and fifth grade students participated in the CSI Club and selected the topic of improving the lives of homeless animals in their community. In this study, we specifically investigate the following two research questions in a public elementary school context: *How can educators engage students in PBL on topics relevant to their community in an after-school setting? How can educators integrate critical mathematics and literacy skills with community engagement?*

Relevant Literature

According to Krajcik and Blumenfeld (2006), PBL has five key features: 1) a driving question, 2) student exploration of the question via inquiry, 3) a collaboration of various members to find solutions to the question or problem, 4) teacher support of students by extending experiences beyond their abilities, and 5) student creation of a project or product that addresses the initial question. In PBL, students work collaboratively to apply knowledge and research to create projects that reflect their learning (Wilhelm & Confrey, 2005). Thus, the collaborative learning often helps students develop communication skills and a responsibility to problem solve. In tasks that are less challenging, students tend to not develop problem solving skills; but when introduced to more complex tasks, PBL "provides more opportunities for solving real problems" (Blumenfeld et al., p. 371). PBL also encourages students to be creative by expressing themselves through projects that are more open and have minimal boundaries. Students can form their own ideas and opinions through research, intellectual debates, and the exploration of topics related to state standards.

Preparing students to be active citizens is an important function of public schooling. For example, Westheimer (2015) argues that the function of schools in democratic societies is to teach students to ask difficult questions; learners must be prepared "to exercise power individually and collectively in their lives, communities, and society" (Prins & Drayton, 2010, p. 209). Yet, civic education often gets pushed to the margins in public school classrooms. This has occurred as a result of emphases on "basic" mathematics and literacy skills, other common core standards, and achievement testing. However, one important aspect of civic education is the application of fundamental mathematics and literacy skills to solve real-world problems. Three primary models of "good citizenship" characterize education programs (Westheimer, 2015). "Personally Responsible Citizen" models emphasize "honesty, integrity, self-discipline, and hard work" (p. 38). "Participatory Citizen" models focus upon active participation in "civic affairs and the social life of the community at local, state, and national levels" (p. 40). Lastly, the "Social Justice-Oriented" model emphasizes critical thinking, the complexity of social issues, and the improvement of society. For example, when approaching the issue of hunger and homelessness, personally responsible models might emphasize contributing to a food bank, while participatory citizen models might help to organize a food drive. A social justice-oriented program, in contrast, might explore the concept of food insecurity and act to solve its root causes. When applied to civic and community education, PBL represents a rich opportunity for learners to learn and apply important mathematics and literacy skills and strategies. Turner, et al. (2009) used critical mathematics to explore topics relevant to a Latino community of students in an after-school club, which allowed for curricular flexibility. They selected the topics of immigration and rebuilding a burned down park based on students' questions. Students gathered and organized data to investigate their questions and determine how they could be active citizens in order to have a positive influence in their community. They were also able to learn about mathematical ideas that were beyond their typical curriculum and grade level. For example, the students learned to about scale when redesigning the community park. The after-school club experience also promoted students' development of positive ideas of mathematics as a discipline that is relevant to their lives.

After-school programs are prominent in public schools, and there is a great deal of research that has examined ways in which experiences in programs might influence academic achievement and behaviors (Kremer, Maynard, Polanin, Vaughn, Sarteschi, 2015). While not all after-school programs are enriching, those that are not still provide an opportunity for students to have support in completing their homework and engage in extracurricular activities that are more beneficial than potentially watching television at home in some cases (Cooper, Valentine, Nye, & Lindsay, 1999). Due to their informal nature, after-school programs have the potential to provide authentic learning experiences for students where they can also develop positive relationships with adults (Noam, 2003). For example, Noam (2003) described an after-school program in a public elementary school in New York City where students took a PBL approach by deciding to raise money for the American Cancer Society. They created a business plan and timeline that included creating and selling crafts over several weeks to raise over $300. Not only were the participants able to use a lot of mathematics and literacy skills, they also felt empowered upon celebrating their accomplishment when "the children handed an oversized check to an official of the American Cancer Society" (p. 122).

Context

Our project occurred during an after-school program at a local public elementary school. The school was diverse overall (54% White, 27% Black, 8% Hispanic, 4% Asian, 7% other). Two-thirds of the students qualified for free and reduced lunch, 12% were categorized as English language learners, and 16% were in special education. The CSI Club met weekly for six weeks for approximately one hour each session. Between 12-18 students in the 4th and 5th grades attended each week, and the club participants reflected the overall diversity in the school population. Seven students (5 girls and 2 boys; 4 in 4th grade and 3 in 5th grade) returned parental consent forms and assented to participate in the research portion of the project. Our research team consisted of two faculty members (one with an expertise in mathematics education and the other in literacy education) and two undergraduate research fellows (one majoring in elementary education and the other in special education). We met weekly for one academic year to review literature, review feedback from students, design club activities, plan data collection, and analyze data. We will refer to ourselves as researchers, but we viewed our role primarily as facilitators of informal learning experiences.

Prior to meeting as a club, we conducted informal interviews with students to learn about their backgrounds and interests. For example, we asked students the following: What is your favorite school topic? What do you like to do for fun? What does your family like to do for fun? Who do you consider to be a part of your community? If you could change one thing in your community what would it be? Based on the information students provided, we identified four broad topics for the students to vote on during our first official CSI Club meeting: 1) nutrition and health in your community, 2) improving the lives of animals, 3) improving the environment in your community, and 4) improving nutrition in your school. An overwhelming majority of the students voted to improve the lives of animals.

Data Collection and Analysis

We used a qualitative approach to better understand what kinds of connections the students made through the after-school club (Yin, 2015). For our data collection, we wrote weekly memos of program activities and noted observations. Artifact collection involved gathering brainstorming posters, presentations, and journals, as well as taking photos of students engaged in project activities such as researching a topic on an iPad. Finally, we conducted semi-structured interviews of assenting students to gain insight into their participation and their learning experience. Example questions from this interview included: Tell me about your experience with the CSI Club. What did you think of the project? What did you learn? How did you apply math and reading/writing skills to the project? How can you apply what you have learned to your life/community? What were some parts of the club that were beneficial? What were some parts of the club that could be improved for next time?

Data analysis involved transcribing the students' interviews and organizing their responses by question in a spreadsheet. The spreadsheet allowed us look across students to generate themes with respect to their responses. To corroborate our findings, we also reviewed students' project journals in which they wrote down questions and notes, other artifacts generated by the students such as a Venn diagram in which they noted mathematics and literacy activities, and our photographs of their participation. Data collection and analysis procedures were carried out over a 12-week period during spring of 2018.

Findings

Our results are presented by research question. The first question we explored was *How can educators engage students in PBL on topics relevant to their community in an after-school setting?* We found three main factors that contributed to students' engagement: 1) selecting a topic of interest, 2) eliciting and using students' ideas, and 3) creating authentic group tasks. The second question investigated was *How can educators integrate critical mathematics and literacy skills with community engagement?* Results indicated that the following three factors provided opportunities for mathematics and literacy connections: 1) community connections, 2) journals, and 3) technology.

The research team engaged students in PBL by giving the students autonomy when they selected their topic of interest, which was to improve the lives of homeless animals in the community. Students also had the freedom to choose on a week to week basis a different small group and task. As facilitators, we elicited and used the students' ideas for every aspect of the project. We helped make sure they understood what their choices were and kept them on track once they began working in small groups. Students brainstormed ideas such as donation drives and raising money to provide necessities for the animals and promoting adoption. Students came up with their own sets of goals for the program, including: finding homes for cats, matching dogs with people, asking questions to match dogs and cats with the right owners (e.g., possible owners' schedules and how an animal would fit into their lifestyle), and leading a donation drive for the local humane society. Students also brainstormed driving questions to help motivate their project and research. For example, how much does it cost to take care of one dog? How often do animals get sick? What is an ideal budget for a potential parent for an animal? What needs do the local humane society need to meet to fully take care of their animals?

All the tasks, such as creating posters to promote adoption and leading a donation drive for the humane society, were based on students' ideas. Choosing their own topic of inquiry put students in charge of their learning and served as a motivator. They were excited about encouraging people at the partnership university to donate items for the local humane society. During one session, students worked on a script to create a promotional video encouraging participation in the donation drive. In order to be inclusive and offer choice, students were informed that they could work on another task (which was creating a shopping list with the money that had been donated thus far) but still participate in the video if they were interested. The informal learning environment and collaborative nature of the tasks of the after-school club also created a positive and low-pressure atmosphere. Hannah, a student in the club, commented on the benefits of collaborating when asked about her experience: "My team helped me figure out how to do things other than making me do all the work. We all kind of worked together. So, they helped me figure things out and then we all we got it done pretty easily."

One community connection that was very engaging for the students was having a guest from the humane society who brought in her adopted dog. This visit was an authentic activity that motivated students to generate questions to ask the guest. Including expert advice is also a feature of PBL (Wilhelm & Confrey, 2005). Below are sample questions students wrote in their journals and/or asked the guest during her visit:

- How many animals are adopted each year?
- Do you enjoy your job?
- What animals are the most and least popular?
- What donation items are most needed?
- What kind of budget do you guys have?
- How long does it take for animals to get adopted?
- Do the small animals get play time as well?

The community aspect not only engaged students in the project, it also provided an opportunity for them to make mathematics connections with their questions. The guest speaker gave the students real data from the local humane society as well as personal stories from her own experience working there. In an interview with Maria, a student in the club, she stated, "We learned that a lot of animals in the town and the shelter that there are a lot of dogs that need to [be] loved."

Students also wrote in journals weekly. This allowed them to document ideas, questions, research findings, and draft posters. After the humane society guest left, students were asked to reflect on at least one thing they learned. Sam wrote, "I learned that animals can be up for adoption for years. I learned that barking dogs are the nice ones." Hannah reflected, "I have learned that they use good food and spend lots of time with each animal and 5,000 are adopted per year." When students wrote down their thoughts, we could also address any misconceptions they might have or ask clarifying questions.

One task in which students made mathematics and literacy connections was drafting an e-mail encouraging people at the partnership university to donate items for the humane society. Students used iPads to research information to include in their e-mails to make them more substantial and persuasive. The researchers guided students to ensure they were using reliable sources to research information. For example, students calculated how many cans of food would be needed to feed all the animals at the shelter for just 1 day. Students created a table of all the dogs up for adoption at the humane society (see Figure 1), used a website to approximate the weights of the dogs based on the breed, and then documented the total number of dogs in each weight category ranging from 10-100 pounds. They then used this

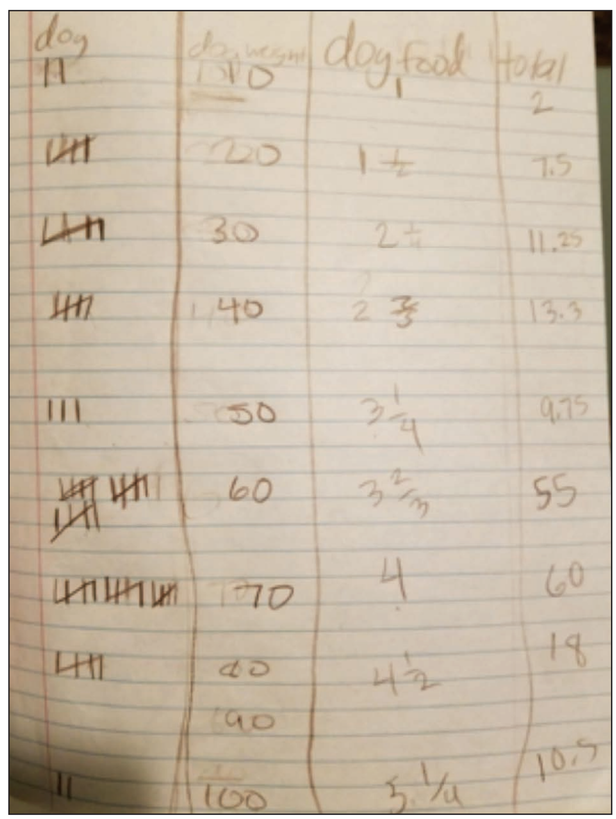

Figure 1. McKenzie's Journal

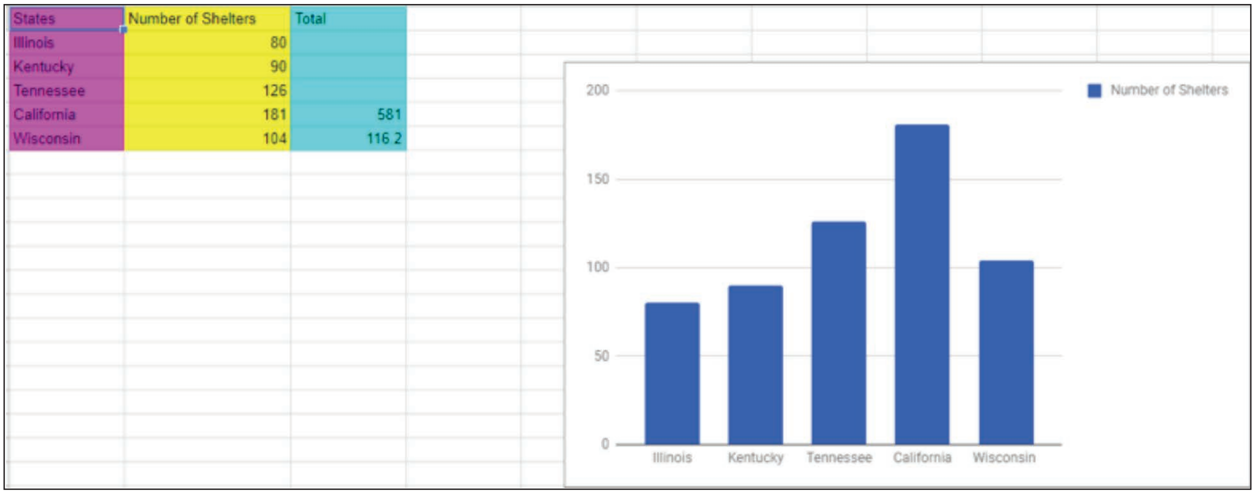

Figure 2. Screenshot of Google spreadsheet created on the iPad

information and the suggested daily serving amounts on the back of a can of dog food to come up with 187.5 cans of dog food to feed all 57 dogs for just 1 day. They also calculated that it would take 10.5 cups of cat food to feed the 21 cats up for adoption. This information was integrated into the text of the e-mail for the donation drive.

Another mathematics connection that was made possible by technology was the students' investigation of how many shelters are across different states in the country. Students used Google spreadsheets to compile data and create graphs such as the number of humane societies in specific states (see Figure 2). Students chose states in which they were interested or had family connections. They then reflected upon this information and the urgent need for animals to be adopted. Kelly, an artistic student in the club, then proceeded to work on flyers to promote the adoption of animals in shelters, which was one way she used her artistic talent. When asked what she would do with the flyers, she said that she would post them around her neighborhood. Sam, another student in the club, noted the critical importance of research in his interview: "My goals were to get as much research as I can, helping the other kids, the other students with all their um goals and what they needed. …Research is the main thing that is helping us progress and the main thing that is helping the humane society."

To learn more about the humane society's needs, students used the internet to view the society's website and came to the consensus to lead a donation drive for its benefit. They created fliers, an e-mail, and a video to encourage donations. Figure 3 shows the chart the students created to summarize the total items in each category according to animal type. These data were gathered by the students working in small groups after sorting the donated items. The mathematics tasks in this project arose from the questions students posed, and the facilitators encouraged mathematics and literacy applications. Overall, the students were proud that they affected so many animals' lives in such a positive way. They worked hard for their project and also learned how to connect mathematics and literacy to civic engagement for the purpose of community and personal betterment!

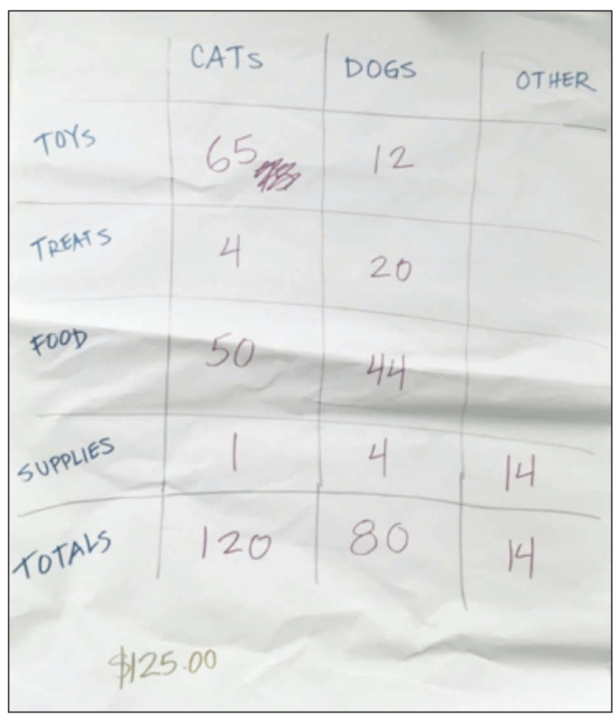

Figure 3. Chart Summarizing Totals based on Categories

Discussion and Implications

Given the time constraints due to the limited number of weekly meetings, we recommend several aspects of our project for replication. Selecting a topic that interested the students and was based on their questions and ideas, a key feature of PBL (Krajcik and Blumenfeld, 2006), was foundational to the success of the project. This allowed students to take ownership of the project and motivated them to investigate the topic of choice. Similarly, the students enjoyed choosing tasks based on ideas the group had generated that week. Since there were four adult leaders, students could work in small groups with guidance. The community connection also made the project into a local issue that was meaningful to the students (Powell, et al., 2001; Turner, et al., 2009). It was clear that the majority of the students had pets, and several had previously visited the local humane society. These two factors motivated their participation. Students also had access to iPads to aid in their weekly tasks. The students were not only savvy in their use of technology, they were also able to research a real-world question that was posed and verify the accuracy of the answers provided. One drawback was that the school's internet speed was not always fast and there were websites that may not have been as easily accessible due to the school district's restrictions. However, this drawback did not frustrate the students nor take away from their experience.

As a first attempt to lead an after-school club, we learned several lessons that will allow us to improve the experience. First, more weekly meetings would be beneficial to the club and the students' project. Depending on the number of leaders available, more students could potentially be invited to join. This first time we wanted to make CSI Club more manageable, and thus limited it to fourth and fifth grade students. Since a major goal of the project was to integrate critical mathematics and literacy skills, we would make the content more explicit next time. The students made several connections, and we think these connections can be highlighted. There is room to integrate more critical and social justice perspectives as well. For example, this first run of the CSI Club fit into Westheimer's (2015) "Participatory Citizen" model of civic education. However, we would like to move future iterations toward a Social Justice-Oriented model of citizenship education. We believe that encouraging students to question the underlying causes behind important community issues and work to solve them will help the students to see the empowering abilities of the mathematics and literacy skills they learn in school. Overall, the benefits to the CSI Club with its community connection and collaborative nature outweighed the limitations.

References

Allen, J. (2010). *Literacy in the welcoming classroom: Creating family-school partnerships that support student learning (kindergarten through grade 5).* New York, NY: Teachers College Press.

Bell, S. (2010). Project-based learning for the 21st century: Skills for the future. *The Clearing House, 83*(2), 39–43.

Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*(3&4), 369–398.

Cooper, H., Valentine, J., Nye, B., & Lindsay, J. (1999). Relationships between five after-school activities and academic achievement. *Journal of Educational Psychology, 91*(2), 369–378.

Domino, J. (2009). Teachers' influences on students' attitudes toward mathematics. *Research and Teaching in Developmental Education, 26*(1), 32–54.

Frankenstein, M. (1983). Critical mathematics education: An application of Paulo Freire's epistemology. *Journal of Education, 165*(4), 315–339.

Khisty, L. L., & Chval, K. B. (2002). Pedagogic discourse and equity in mathematics: When teachers' talk matters. *Mathematics Education Research Journal, 14*(3), 154–168.

Krajcik, J. S., & Blumenfeld, P. C. (2006). Project-based learning. In R. K. Sawyer (Ed.), *Cambridge Handbook of the Learning Sciences* (pp. 317-333). New York, NY: Cambridge University Press.

Kremer, K. P., Maynard, B. R., Polanin, J. R., Vaughn, M. G., & Sarteschi, C. M. (2015). Effects of after-school programs with at-risk youth on attendance and externalizing behaviors: A systematic review and meta-analysis. *Journal of Youth and Adolescence, 44*(3), 616–636.

Noam, G. G. (2003). Learning with excitement: Bridging school and after-school worlds and project-based learning. *New Directions for Student Leadership, 2003*(97), 121–138.

Powell, R., Cantrell, S. C., Adams, S. (2001). Saving Black Mountain: The promise of critical literacy in a multicultural democracy. *The Reading Teacher, 54*(8), 772–781.

Prins, E., & Drayton, B. (2010). Adult education for the empowerment of individuals and communities. In C. E. Kasworm, A. D. Rose, & J. M. Ross-Gordon (Eds.), *Handbook of Adult and Continuing Education* (pp. 209–219). Thousand Oaks, CA: Sage Publications, Inc.

Turner, E. E., Gutiérrez, M. V., Simic-Muller, K., & Díez-Palomar, J. (2009). "Everything is math in the whole world": Integrating critical and community knowledge in authentic mathematical investigations with elementary Latina/o students. *Mathematical Thinking and Learning, 11*(3), 136–157.

Westheimer, J. (2015). *What kind of citizen?: Educating our children for the common good.* New York, NY: Teachers College Press.

Wilhelm, J., & Confrey, J. (2005). Designing project-enhanced environments. *The Science Teacher, 72*(9), 42–45.

Yin, R. K. (2015). *Qualitative research from start to finish.* New York, NY: The Guilford Press.