Journal of Urban Mathematics Education
December 2018, Vol. 11, No. 1&2, pp. 142–151

Revisiting the Influence of Math Links: Building Learning Communities in Urban Settings

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It has been a decade since the article "Math Links: Building Learning Communities in Urban Settings" (referenced throughout as Math Links) was published in the inaugural issue of the *Journal of Urban Mathematics Education* (*JUME;* Leonard & Evans, 2008). The Math Links study, as reported in that article, investigated teacher interns' attitudes and beliefs about their interactions with urban students in a community-based setting. In that article, it was acknowledged that changing teacher attitudes and beliefs can be challenging, but nonetheless accomplished. The goal for the teacher interns was to transform attitudes and beliefs about teaching mathematics to urban students from routine and decontextualized ways to classroom practices in which culturally based and social justice oriented methods framed instruction. Here, we reflect on that work for the 10th anniversary issue of *JUME* and how that project has influenced our teaching, research, and scholarship in mathematics education over the past decade.

Math Links Influence on Jacqueline (Jackie) and Brian

Jackie's Narrative

After completing the community-based study in Philadelphia, Pennsylvania, which was supported by Temple University and The United Methodist Church, Office of Urban Ministries, I realized that grounding this work was the way to engage urban youth from underrepresented backgrounds in culturally relevant and place-based science, technology, engineering, and mathematics (STEM) education. In the Math Links study, preservice teachers provided students with culturally relevant, hands-on STEM instruction (Leonard, 2002; Leonard, Moore, & Spearman, 2007). The sites included Mount Zion United Methodist Church and Tindley Temple United Methodist Church. Children and youth who participated in Math Links, as well

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as its predecessor, Earth Links, were eager to attend classes at the community-based sites. Anecdotal records revealed one African American boy insisted that his mother get up early on Saturday to ensure that he arrived on time. When certificates of attendance were provided during a Sunday church service, an African American girl did not feel the need to be recognized as an outsider stating, "I already go here." Through community-based STEM programs, underrepresented minority students from urban settings developed a STEM identity as well as individual and community agency as members of the congregation and community helped them to learn and achieve educational goals in culturally relevant ways.

Since leaving Temple University and Philadelphia in 2010, this model was transferred to my new setting at the University of Colorado, Denver where I worked from 2010 to 2012. While in Colorado, I worked in collaboration with Iglesia Y Vida, Shorter African Methodist Episcopal Church, Campbell Chapel African Methodist Episcopal Church, and the Oleta Crain Enrichment Center in Denver. The project entitled Dinosaurs, Denver, and Climate Change (D^2C^2) was funded by the National Science Foundation (NSF). It provided urban children with the opportunity to learn about paleontology and environmental science within the context of place-based education. Twenty-four youth and young adults served as interns (also called near-peer mentors) in the summer of 2013 or 2014 (Leonard, Chamberlin, Bailey, Verma, & Douglass, in press). More than 60 children from African American and Latinx backgrounds participated in the study (Djonko-Moore, Leonard, Holifield, Bailey, & Almughyirah, 2018; Leonard, Chamberlin, Johnson, & Verma, 2016). In this informal learning environment, students assisted in maintaining a compost for one week. They also learned about climate change by taking field trips to a science museum, botanical garden, and national park. Several students responded positively to the study:

> The coolest thing was starting a compost … I watch TV shows; composts aren't that big. But now that we are doing compost, it takes a lot of work.
>
> My favorite [*sic*] day was at the nature and science museum because when me and Master Chief [near-peer mentor] stuck our hand in a hole, and we were both scared, and we looked inside it, and it was deer hide.
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> My favorite part of the [field] trips so far is the Botanic Garden. First, the Japanese Garden was beautiful. There were many lily pads with wonderful flowers. Second, was the Survivor. We saw many plant-like [banana] trees. Third, there were pretty flowers. All of the flowers I saw were glamourous like Queen Anne's lace. All in all, my favorite part of the trip so far is the Botanic Garden, and going there makes me feel like a calm bee.

Not all of the students enjoyed every activity that took place during the summer camp. Some of the constructive comments made by students include:

> I didn't really like the botanic gardens because it was kind of boring, and there was a lot of walking. And nature, to me, is basically plants. It's just plants, so they really don't interest me.
>
> It was scary to me a little bit by the mountain because we saw a coyote…. It wasn't that cool because it was limping.
>
> When we went to the mountains, I didn't like the scat because it was everywhere…. Scat is poop.

The researchers used the feedback received from students to prepare future urban students for STEM learning in informal settings and to develop rich cohesive programs for preservice teachers and students.

After working with students in Denver, two additional projects were funded by the NSF in 2013 and 2014, respectively, during my role as director of the Science and Mathematics Teaching Center from August 2012 to July 2016 at the University of Wyoming. The first project was funded under the Robert Noyce Teacher Scholarship program. Thirty summer interns and 24 scholars were recruited for the Wyoming Interns to Teacher Scholars (WITS) study. Summer interns participated in rural (n = 28) and urban (n = 2) settings. Ten of these interns identified as racial, ethnic, or language minorities (4 African American, 3 Native American, 2 Latina, and 1 Biracial). However, the majority of the interns identified as White (n = 23). In Wyoming, interns worked in numerous settings such as state parks (i.e., Sinks Canyon), Starbase in Cheyenne, Teton Science Schools in Jackson and Saratoga, summer school in Lander, and summer camps at the University of Wyoming in Laramie. These summer research experiences were used to recruit prospective STEM majors into teaching (Leonard, Aryana, Johnson, & Mitchell, 2015) and to build upon the collaborative and community-based model developed in the Math Links study. Comments from several summer interns include:

> We learned how to teach using place-based education in a positive learning environment.
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> In Jackson, I had the experience of learning place-based education in Jackson. I also used place-based education on the field trips that I went on for Lander.
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> I worked in the art section and we learned how to make chromatography, teaching the students how to grow their own crystals, experiments with different solutions.
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> I helped teach lessons in an earth science classroom. We built a lot of things with our hands (e.g., pulley systems, ramps, wedges, etc.). The focus of the week was mechanical science.
>
> Teton Science Schools allowed me to participate in the developing of lesson plans and the presentation of lessons to the children, which allowed me to understand the efforts

> it takes from beginning to end with how a teaching lesson is formed and then presented.

In addition to these rural settings, two students requested to complete their summer internship in an urban setting. They worked with predominantly African American students during a STEM summer camp at Temple University in Philadelphia in 2016. Some excerpts of children's comments that were obtained from focus groups in this setting include:

> What I thought was cool was how we was able to make actual live robots, and I also liked that we were able to program different types of video games.

> I liked how we got to make the robots out of LEGOs because usually LEGOs take a very long time to put together and to start moving cause you to have to push it, but it is neat how we got to use the iPads to control them.

> I like how we got to customize our characters and program them, and I also liked how we could program our games and people could actually play them.

> I did not like my group because they were not very cooperative with everyone. Like they had jobs for a builder, operator and then they had a go-getter to find different LEGOs and then they had a me.

> I didn't like that it was hard to program your character in your game.

While a few students had some level of frustration with roles during robotics and difficulty programming during game design, other students noted enjoying the opportunity to create, tinker with, build, and/or program robots and digital games. The male teacher interns, who identified as minorities, developed robust relationships with the students. Although the study was not community-based, it used the Math Links internship model to develop teaching opportunities for undergraduate students.

The second project, uGame-iCompute, was conducted in several districts in Wyoming and one urban district in Philadelphia. It was funded by the Innovative Technology Experiences for Students and Teachers (ITEST) program at NSF. In this project, 45 teachers worked with more than 950 students from 2014 to 2016 during afterschool programs to promote STEM education using robotics and game design in the contexts of culture and place (Leonard et al., 2016). In the urban context, practicing teachers noticed students' performance (i.e., motivation, effort, and learning) in informal settings was different than their performance in traditional classrooms:

> The independent learning part was big for me. It actually totally changed the way I teach. Period. That the kids were able to go on to the NXT web site and look up how to

> build like…different things. It wasn't just like OK guys today we're going to build this. They were in charge of their own learning.
>
> It's not all teacher directed. The students are helping each other out and they're like "let's find this out together." There's really a lot of collaboration between them, and we don't have to…hands-off on our part and hands-on on theirs…to where we're not always…having to, "Oh, let me help you here, let me help you there, let me help you there." They're helping each other, you know, which is really nice!
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> The accountability…kinda comes back to them, in knowing that they have a stake in their own learning, when it comes to a particular math, you know. That they can look through their computation and find out what went wrong knowing that numbers only line up a certain way, and either you made a mistake, or you didn't program your equation the right way.

In this study, teachers learned much about their teaching and students. Teachers engaged in active learning and culturally relevant pedagogy rather than teaching by telling and allowed students to engage in critical thinking and inquiry as they drew upon culture and place. During robotics and game design, students demonstrated autonomy and were self-directed. Similar to the Math Links study, teachers' pedagogy was influenced by the learning and engagement they witnessed during afterschool STEM clubs (Leonard et al., 2017).

The aforementioned studies build upon the Math Links model. In addition to these research studies, the model has been employed internationally. I was selected as a Fulbright Canada Research Chair in STEM Education at the University of Calgary in fall 2018. In Calgary, I plan to work with Indigenous students in community-based settings on Scalable Game Design (Repenning et al., 2015) and 3-D computer modeling.

Brian's Narrative

At the time of the original publication of Math Links, I was early in a tenure-track assistant professor position in mathematics education in the School of Education at Pace University. In 2011, I was tenured and promoted to associate professor, and more recently to full professor. I also transitioned to an administrative position at Pace as Assistant Provost for Experiential Learning. In this position, I had been developing and coordinating a signature program that combines academics with real-world experiential learning, mentoring, and planning in order to give students a rich and robust college experience. I also became the managing editor of a peer-reviewed research journal focused on alternative teacher certification, which constitutes a large part of the teacher education program at Pace. The *Journal of the National Association for Alternative Certification* (*JNAAC*) is the leading research journal for alternative teacher certification.

In each issue of *JNAAC*, I publish an article in the Editor's Perspective section. In each article, I either present a research study I have conducted or more typically, a perspective on education. One of my most recent articles (Evans, 2017) relates to the importance of affective variables for new alternative certification teachers and alludes to my own shift in viewing successful and effective teaching through this lens and framework. In the article, I provide an example of two different teachers; below is an excerpt from that article:

> Imagine we have two teachers, Teacher A and Teacher B. Teacher A has a very strong academic background and a solid grasp on educational research and theory. Teacher A knows the works of Vygotsky, Piaget, and Dewey very well, and Teacher A understands how children develop and learn. Teacher A's pedagogical skills are very strong. Teacher B struggled with coursework in college (and elementary and high school as well). Teacher B does not have a strong understanding of educational research, theory, and pedagogical skills. However, Teacher B understands how to connect with people. Students simply love Teacher B, and they know Teacher B has their interests as a top priority. Teacher A does not really like young people all that much even though Teacher A chose to be a teacher. Teacher A has trouble connecting with students and finds it challenging to communicate with them. While the students believe Teacher A is very knowledgeable and accomplished, they do not have much respect for Teacher A. They find Teacher A unnecessarily difficult toward them, and often think Teacher A really does not prefer to be a teacher. Who do you think will have more success with the students? Interestingly, it is likely Teacher B. I certainly do not wish to imply that content knowledge and pedagogy are unimportant. They absolutely are. However, content knowledge and pedagogical skills are not the only variables to consider for teaching success and may not even be the most important variables in every situation. Lessons such as this one have been critical to my own development as a professor of education. (p. 23)

In the article, I reference the experiential learning program that I developed and had coordinated at Pace University. This work is related to a finding in the Math Links study, which emphasized the importance of providing preservice teachers with field-based experience prior to student teaching. Early field experience influenced how I have positioned experiential learning at Pace. This influence coincides with the overarching philosophy of the School of Education's teacher preparation program that students receive field experiences early in the teacher education program. Math Links influenced my approach to working toward early involvement and increased field experiences for other majors at Pace.

The link between teaching mathematics for social justice was an important aspect in the Math Links study as well, which coincides with the School of Education's conceptual framework at Pace:

> The School of Education believes that a fundamental aim in education is to create opportunities for individuals to realize their potential within a democratic community. Therefore, we prepare graduates of our programs to be reflective practitioners who pro-

> mote justice, create caring classrooms and school communities, and enable all students to be successful learners. (Pace University School of Education, 2017)

I have continued to teach mathematics methods to graduate students in alternative teacher certification and undergraduate students in traditional preservice teacher programs. Perhaps the most impactful and sustained influence of Math Links is the shift in emphasis on the affective variables related to high-quality and effective teaching, such as teacher attitudes and beliefs, self-efficacy, culturally responsive pedagogy, social justice, and rapport and trust between teacher and students. During graduate school and early into my tenure-track assistant professor position, I was committed to reform-based mathematics education utilizing a sociocultural perspective within a constructivist framework. I believed that culturally responsive pedagogy was an essential ingredient for effective teaching in urban schools. Nevertheless, I continued to prioritize mathematics content and traditional pedagogical knowledge as the two most important variables for successful and effective teaching. By examining research on preservice teachers' attitudes, beliefs, self-efficacy, and culturally responsive pedagogy, I experienced a major conceptual shift in priorities as it related to successful and effective teaching. While I continue to acknowledge the importance of mathematics content and pedagogical knowledge, such as mathematical knowledge for teaching (Ball, 2005), I now believe that affective variables are more important for effective teaching than is perhaps commonly acknowledged. This affective framework is supported in the work of several authors; Leonard (2008), Ladson-Billings (1994, 1995), and Martin (2007) are just a few examples.

In my mathematics methods courses, I use this affective framework to help preservice teachers understand the importance of their own development as teachers in the critical areas of academic, social, and developmental learning. I learned that in-service and preservice teachers, like I once thought, tended to believe that content and traditional pedagogical knowledge are the most important variables for classroom success. While I have not formally collected evidence, I sense that teachers left my courses with a changed disposition and reformed attitudes toward culturally responsive pedagogy and teaching mathematics for social justice. The Math Links study emphasized that teacher interns should not consider social justice in a vacuum but rather consider social justice in the real-world context of the classroom. This finding has influenced my instruction and use of fieldwork as the basis for practice in my courses. Furthermore, Math Links contributed to the idea that a formal study on teacher change could build upon my assumptions and practice.

Finally, I have been traveling to Shanghai, China, yearly for the last couple of years to work with teachers on teacher assessment and curriculum development. My focus has been on using the Danielson Framework (Danielson, 2018) to evaluate teaching and the use of data collection to improve instruction. I have used Wiggins and McTighe's (2005) Backwards Design in order to plan lessons and units in

American and Chinese curricula. Lessons learned in China have influenced my work with preservice and in-service teachers, expanding the community-based model to a global model. This work has complemented my teaching at Pace.

Closing Thoughts

While our (Jackie's and Brian's) progressions as researchers and teacher educators cannot solely be attributed to Math Links over the last decade, there is no doubt that findings from the Math Links study have been highly influential in our research and pedagogy. For both of us, the Math Links study, along with other teaching and research opportunities, shaped our perspectives on teacher attitudes and beliefs. Perhaps the most important finding from the Math Links study was the acknowledgment that teacher attitudes and beliefs are malleable. Math Links provided us with the impetus to continue our efforts to shape teacher attitudes and beliefs toward teaching by providing field experiences that allowed teachers to practice teaching mathematics (or STEM) for cultural relevance and social justice in urban contexts. Reflecting on Math Links has helped us realize that the findings from the study provided a catalyst for future research and ideas on how to influence positive teacher attitudes and beliefs about urban students.

As we reflected on the changes that have occurred since the publication of Math Links at the end of 2008, the country was in financial crisis and had just elected its first African American president, who would serve two terms over the next 8 years. Brian still recalls where he was while watching the results from a restaurant in Brooklyn, New York. After Barack Obama had been declared the winner, Brian walked the streets of Brooklyn, and then Times Square, to experience the historical moment along with the celebrations.

Jackie had the privilege of hearing Candidate Obama at Progress Plaza near Temple University during the 2008 campaign. It was surreal to hear a brilliant, young African American senator talk about education, healthcare, and uplift in a Black community. Jackie personally benefitted from President Obama's educational initiatives for more STEM teachers when she received a Robert Noyce grant. However, there are those who believe Obama fell short by not articulating a clear vision to deal with state violence (Davis, 2016; Taylor, 2016). The deaths of Trayvon Martin, Michael Brown, and many others occurred during the Obama administration. The uprisings in Ferguson and Baltimore took place on Obama's watch. Attorney General Eric Holder's visit to Ferguson was historic and comforting, but few policies other than establishing the Ferguson Commission and adding police bodycams have resulted from the Michael Brown tragedy. Clearly, it takes more than the presidency of one Black man to tear down centuries of racism and prejudice.

At the time of this publication, we are more than two years into the presidency of Donald Trump. It feels like the country has taken a big step backward as the Alt-Right has become empowered and emboldened by xenophobic and racist ideology. Yet, other important social justice movements have strengthened during, or because of, the Trump presidency (e.g., #BlackLivesMatter, #NeverAgain, #TimesUp, #MeToo). Along with the protesters in Charlottesville and the Women's March in Washington, DC, many people have voiced their dissent. Teachers across the country took to the streets to advocate for higher wages and greater resources for their students. Through public discourse and protests, we have seen the country take a serious look at police brutality, sexual abuse, and gun violence in our nation's schools. These resistance movements give us the audacity to hope that we will eventually see that "justice rolls down like the waters and righteousness like an ever-flowing stream" (Amos 5:24).[1] When that happens, trust, which has eroded in Black and Brown communities, will hopefully be restored as well.

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