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Gladys Krause

William & Mary - School of Education, ghkrause@wm.edu

Gustavo Velandia

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Geometric Shapes that Sing and Move: An Interdisciplinary Lesson with Pre-service Teachers

Gladys H. Krause

William and Mary, Williamsburg, Virginia, USA

ghkrause@wm.edu

Gustavo Velandia

Pontificia Universidad Javeriana, Bogotá, Cundinamarca, COLOMBIA

gustavo.velandia@javeriana.edu.co

Synopsis

Our work shares a practical example of an interdisciplinary lesson in which two teacher educators collaborated to integrate mathematics and music in an elementary mathematics methods course. This paper describes the process of collaboration in designing the lesson and shares original instructional resources to be used in the classroom. We also discuss what the pre-service teachers participating in the lesson shared about their learning experience, and what we, the teacher educators, learned from this experience. In presenting this work, we aim to promote the opening of spaces in teacher preparation programs that allow pre-service teachers to develop their own instructional resources, while seeking opportunities to create interdisciplinary instruction in their own classrooms.

Teaching across content areas seems to continuously receive more attention in educational research and in the study of effective instructional practices [11]. In the teaching of mathematics, we have seen examples of integrating science and mathematics, social studies, and arts. For example, the National Council of Teachers of Mathematics (NCTM) has published an online resource called *Integrating Math across the K-6 Curriculum* [10]. In that work, the editors share lesson plans, instructional resources, and peer reviewed articles with sample lessons and activities on science, social studies, and the arts all connected to the teaching of mathematics content.

In the book *Rethinking Mathematics Teaching: Social Justice by the Numbers* [5], the editors have provided more than fifty lessons designed specifically to promote equitable practices weaving social justice issues throughout the mathematics content; similar resources can be found for example in [3, 7]. We have also seen the integration of mathematics with music. For example, Perger *et al.* [14] present a case of how to use patterns in algebra as students engage in playing music. Johnson and Edelson [6] shared their work in PK-3 classes where patterns, order, sorting, Venn Diagrams, ratios, and fractions are all introduced through music. This work provides a range of knowledge and experiences that support the importance of using cross-content connections in the learning of mathematics.

Unfortunately, we rarely do we see this integration in working with pre-service teachers (PSTs). Some of the few examples describing the integration between mathematics and content areas in working with PSTs relate to the teaching of mathematics and science. For instance, Sackes *et al.* [15] studied the impact of a merged science and mathematics methods course on pre-service early childhood teachers' efficacy beliefs for integrating science and mathematics. Similarly, Kim and Bolger [8] studied the potential for engaging elementary school PSTs in development of science, technology, engineering, arts, and mathematics (STEAM) lesson plans within a science methods course to elucidate changes in the PSTs' perceived ability, value, and commitment for STEAM. A study by An [1] presented a different perspective and investigated the integration of mathematics and music when working with PSTs. The study acknowledged the need for exploring more connections between mathematics and other content areas, and in particular music.

In the work we present here we describe how we attempted to create a space in a mathematics methods course to connect the learning of mathematics to music. Our intention in creating this space was to explore learning opportunities for PSTs that allow them to develop their own ideas on how to create interdisciplinary instruction in their own classrooms. In this paper, we present how we designed a lesson for PSTs, share the resources we created, describe how PSTs reflected on this lesson, and reflect on our learning as teacher educators throughout this experience. All this is with the hope that this article equips teacher educators and in-service teachers with tools, suggestions, and recommendations for implementing similar learning experiences in their courses.

1. Background

1.1. *The Classroom*

We taught this lesson in an elementary mathematics methods course at a university in Virginia, United States. The first author GHK is the primary instructor for the class, and the second author was invited to collaborate on this lesson. In this mathematics methods course, PSTs engaged in learning and exploring what it means to learn and teach mathematics with understanding, and how they can help students from diverse cultural, racial, social, and linguistic backgrounds appreciate its beauty and power. In this class we also focused on how children think about mathematics, and we learned to use what we know about children's thinking to design and adapt instructional tasks. The class, taught entirely in English, had twenty-eight students, three of whom were bilingual: one Spanish-English, one French-English, and one Chinese-English.

1.2. *The Instructors*

The first author GHK is a Latina, Spanish-English bilingual mathematics educator. Most of her work as an educator has centered on foregrounding the voice and richness of bilingual children's ideas in the mathematics classroom in the United States. The second author GV is a Latino, Spanish-English music educator. Most of his work aims at providing tools for in-service music teachers in Colombia. In his work creativity plays an important role in the teaching-learning process. He currently teaches K-12 students, as well as pre- and in-service teachers. He has more than twenty years of experience working with in-service teachers around the world.

2. Our Lesson

In developing the lesson for the PSTs, our goal was to integrate learning in such a way that knowledge could be related and connected to the mathematics and the music content we wanted to address. We stipulated at the outset that we wanted to ensure that both mathematics and music were foregrounded in the lesson, rather than one being used in the service of the other. In this way, we also worked towards avoiding what researchers have described as a drawback of integration: that the integrity of one (or more) of the subjects goes away [14]. We both wanted this lesson to serve the PSTs as an example of what an integrated lesson could look like in their own classrooms.

At the same time, we both wanted to provide an opportunity for the PSTs to experience learning in a somewhat different context. We co-designed and co-taught the lesson. This was intentional because we wanted to provide a model for collaboration as well. We both proposed ideas for content to be covered.

We decided to focus on geometric shapes, because we were both familiar with resources that could align well with teaching geometric shapes. In addition, it was important for us to attend to rhythmic patterns tied to creating geometric shapes (e.g. making triangles with our arms, or fingers, etc.). These rhythmic patterns are so common in our daily routines, in particular teaching, that we tend to forget them or include them purposefully in our teaching practices.

We decided to use the book *Una Historia de Formas* [16]. This is a picture book that foregrounds the use of shapes such as triangles, squares, rectangles, circles, and rhombus. Each page of the book is dedicated to one shape. Since the book is wordless there are infinitely many possibilities to imagine what is happening in the story. GV had used it before in a different lesson with K-12 teachers from Iran. This experience provided us with ideas of how we could incorporate the book into the lesson. Once we chose the book and decided to focus on geometric shapes, we turned to designing the lesson. Our lesson had three parts, described below.

2.1. Part 1

We started by asking the PSTs to “draw” geometric shapes in the air with their fingers based on the number of strokes we could do with our fingers. For example, the second author asked the question: “What shape could we draw with one stroke?” Instead of answering aloud, students were asked to draw the figure with their fingers in the air. With this decision we were working on modeling and promoting practices that provide opportunities for everyone to participate. In this case we were not asking for students “to talk” in order to participate we were welcoming a “different” way of participating that did not involve talking. Additionally, the practice of gesturing is not only an important instructional resource due to its visibility but also because it supports the process of mathematics learning by offering opportunities to see, feel, and understand mathematics in new ways [13]. PSTs drew a circle as we anticipated. We asked the same question, but for two strokes, we anticipated PST creating a half-disk.

Then we asked for 3 strokes, and we anticipated a triangle, and 4 strokes we anticipated they would create a square or rectangle. Then, when we asked for a geometric shape with 5 strokes, we also proposed that they could draw 2 shapes. Here we anticipated they could draw a pentagon or a triangle and a half-disk, or a circle and a square, etc. As PSTs created the shapes, we followed up by notating the addition of the number of strokes, for example $2 + 3 = 5$, etc. We did this with numbers up to 10.

2.2. Part 2

We then introduced the book [16]. GV proposed a set of rhymes based on the images of the book. Each rhyme foregrounded the geometric shape that was presented on each page. For example, we started with triangles based on the images on the first page of the book. In the same way, each page foregrounded a shape and we presented a rhyme for each. The rhymes we came up with were:

I am Miss Triangle
and I don't know how
every single morning
I lose my [cow]

This is my home
I am Mr. Square
I have a little cat
and also a little [bird]

I am Rectangle Knight
and I protect my tower
if you don't believe me
then you will know my [power]

My name is Friar Circle
I have an apple tree
and if you want the fruits
you can have them for [free]

My name is Lady Rhombus
and I play the lute
I play it for me
and also for [you]

We introduced each page by asking different questions to engage PSTs in looking carefully at the details of the pages. For example, when we presented the page with the triangles, we asked PSTs to identify how many triangles were on the page. Each time we introduced a new page, the second author played the song “Simple Simon” [12] with the recorder. The class sang the rhyme as he introduced it. After we went through the entire book and covered all the geometric shapes in it (e.g. triangle, square, rectangle, rhombus, and circle), we sent PSTs to work in groups to design their own rhymes. We also asked them to incorporate choreography. We gave them 10 minutes to develop this. Each of the five groups worked on a different shape. At the end of the 10 minutes, one student sang the rhyme while the rest enacted the choreography. Needless to say, this was incredibly fun! In this part we focused on their capacity to observe, be creative, work collaboratively, and pay attention to detail.

2.3. Part 3

After we sang and danced, we engaged in the last part of our lesson. Here we combined some of the aspects we had used thus far in the lesson and incorporated a few new ideas. Here the second author GV sang a song he composed for the class: “Del Uno al Diez”. For the lyrics and the score, see Appendix A. As GV sang the song accompanied by the guitar, we asked students to accompany him with claps. Then he proposed that, instead of singing the number in English, we count in Spanish. As we said the numbers in Spanish, we also had to represent the number with our fingers. Lastly, we sang again, counted in Spanish and, instead of showing the number with the fingers, we created shapes on the air with the same number of sides.

3. What We Learned – Findings

Immediately after the lesson we asked PSTs to share some of their reflections on their own learning experience. We asked a few questions that would help us identify the strengths of the lesson, areas of improvement, and what PSTs had learned from the lesson. As the instructors for the lesson, we also reflected on our own experience collaborating in the design and implementation of the lesson. Below we summarize what we found.

3.1. PSTs Reflecting on their Learning

One of the questions we asked was: *For you, what was the most significant learning experience from today?* We received a range of responses. For in-

stance, one PST said that the most significant learning experience for her was to see how a core subject like mathematics could be incorporated with a “center” subject. We cannot make any conjectures on how PSTs perceive mathematics and other subjects based on the evidence we collected. However the answer suggests that we, as teacher educators, should consider highlighting interconnections among a wider range of subjects, and not only those subjects commonly paired, such as science and mathematics. Connecting core subjects such as mathematics and science might come naturally, because typically the same elementary school teacher teaches both; however the “centers” are taught by a different teacher. We also collected other answers describing how much they thought about creativity, how much they liked the collaboration coming up with the rhymes and the choreography, and how the lesson made them think about movement.

We also asked a question about their own development as teachers: *In what ways did today’s activities inform your development as a teacher?* Here PSTs also shared a great range of ideas. For instance, one PST said:

I think this class informed my development as a teacher by showing me how engaging and creative you can be as a teacher, specifically with math. I don’t usually view math as a “creative” subject, but seeing that you can make jingles, choreography, rhymes, etc., with something only related to math was eye-opening.

Creativity was again at the center. It was also important for us to see how this PST acknowledged her changing perspective on mathematics as a subject. Another PST shared the following reflection:

I liked seeing a concrete, practical way to apply the ideas of integration and engage students with math beyond the traditional formatting. I think these activities could also create opportunities to ask students about what they are doing and why. I also was able to go out of my comfort zone to try something new!

For this PST seeing the applicability of the ideas in the activities themselves was helpful. Additionally, the comment on getting out of the comfort zone and trying something new was important to us as teacher educators. Teaching mathematics based on children’s mathematical thinking requires a teaching style that is centered on the child and not the teacher. In order to put the student at the center, we need to create ways to encourage their

participation and contribution to the learning experience of the classroom community. This lesson provides a good model of how we could accomplish this.

3.2. Incorporating Another Language

As mentioned earlier, the mathematics methods course where this lesson was incorporated emphasizes linguistic practices in the mathematics classrooms. For that reason, the incorporation of language in the lesson was important to us. On the one hand, we incorporated language by counting. On the other hand, in the lesson both languages mixed fluidly in the moment. PSTs moved from counting in English to counting in Spanish. All of them made the switch without expressing any difficulties. One of the students wrote in the reflection:

All of the activities that we did today were applicable to our future classrooms. I really loved the first activity in singing the song and saying the numbers in English and Spanish. I thought it was a great idea to do with ESL students and allows them to work with numbers and words. It involves repetition, movement, and language in both English and Spanish.

Teaching mathematics and encouraging bilingualism is a complex task [2, 9]. In this activity, we did not explore anything more than asking PSTs to count in Spanish. However, the experience of incorporating counting in Spanish unexpectedly was intentional. We were looking to collect the reactions of the PSTs. We wanted to see how they approached it, what they would say, and what they would think of it. Overall, we found that they noticed it and that they did not freeze. Some of them recognized the addition of the task and noticed the value of incorporating language teaching even when teaching mathematics.

3.3. Our Own Learning

For both of us, the collaboration itself proved a major learning experience. We each brought different perspectives on teaching and learning: although we both prepare future teachers, we work in different subject areas, with different populations of PSTs, in different contexts, in different countries, and in different languages. We can highlight different aspects of learning from working together, but after our reflecting individually and then sharing our learning experiences with each other, we believe that our most significant

learning experience was making these experience valuable for teaching both content areas. We did not center solely on music or on mathematics. We did not use one as a vehicle to teach the other. We foregrounded both content areas, and we foregrounded instructional practices important for all teachers. In the end we brought two different perspectives to this collaboration, but we also discovered that we have many in common.

3.4. *What Comes Next?*

Since our collaboration, GV modified this lesson and used it with his PK-5 students. He added one more area to the lesson: art. After the implementation of the lesson, GHK noticed frequent references to implementing interdisciplinary lessons in teaching throughout the rest of the semester. This very fact facilitated the design and implementation of an interdisciplinary lesson across the science, social studies, ELA, and mathematics methods courses at her school of education. What ideas, lessons, activities, and collaborations might this paper inspire for you?

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A. The Score and the Lyrics for “Del uno al diez” by G. Velandia (2021)

Del Uno al Diez
From One to Ten Gustavo Velandia

♩ = 90

Voice

G A m D7

I met a li-ttle horse who was ha-ving lots of

G E7 A m D7

4 fun and he likes to count and count on-ly up to num-ber

G

8 one. U - no _____

2021©

Del Uno al Diez by Gustavo Velandia

I met a little horse
who was having lots of fun
and he likes to count and count
only up to number one (Uno)

I met a little horse
who likes the color blue
and he likes to count and count
only up to number two (Dos)

I met a little horse
that had a little flea
and he likes to count and count
only up to number three (Tres)

I met a little horse
who always cleaned the floor
and he likes to count and count
only up to number four (Cuatro)

I met a little horse
who enjoyed living life
and he likes to count and count
only up to number five (Cinco)

I met a little horse
that he likes to build with bricks
and he likes to count and count
only up to number six (Seis)

I met a little horse
who wants to travel to heaven
and he likes to count and count
only up to number seven (Siete)

I met a little horse
that closed the black gate
and he likes to count and count
only up to number eight (Ocho)

I met a little horse
who writes a red line
and he likes to count and count
only up to number nine (Nueve)

I met a little horse
who lost his little blue pen
and he likes to count and count
only up to number ten (Diez)

For more on this song, including a recording of GV singing the first stanza accompanied by the guitar, see <https://gladyskrause.pages.wm.edu/mathematics-music/>.