CREATING MONSTERS ISN'T FUN: CHALLENGES IN CREATING PLAYFUL MATH PROFESSIONAL DEVELOPMENT

Candice Love	Amy Parks	Brittany Caldwell
Vanderbilt University	Michigan State University	Vanderbilt University
candice.love@vanderbilt.edu	parksamy@msu.edu	brittany.caldwell@vanderbilt.edu

This paper examines two activities in a weeklong Professional Development (PD) focused on implementing mathematical play in kindergarten classrooms. Though the weekly activities all had different goals, the two focal activities (Pattern Blocks and Create-a-Monster) were designed specifically to be both playful and mathematically engaging for the kindergarten teachers taking part in the PD. This analysis looks at why Create-a-Monster fell short of those goals and compares it to the more successful Pattern Blocks to better understand how to design activities that are playful and mathematically interesting activity for early elementary educators. We finish with implications and future directions on playful PD design.

Keywords: Professional Development; Early Childhood Education; Elementary School Education.

Over the last few decades, a consensus has developed about the importance of play in early mathematics learning (Seo & Ginsburg, 2004; Wolfgang, Stannard & Jones, 2003). Research has documented that young children learn a variety of mathematics through play, such as developing spatial reasoning through block building (Casey et al, 2008) and making sense of magnitude through linear board games (Siegler & Ramani, 2009). More broadly, mathematicians have argued that mathematical play provides opportunities for children to engage in mathematical ways of knowing, such as exploration and argumentation, in ways similar to the work of mathematicians (e.g., Oughton et al, 2022).

However, the routines and practices of everyday school mathematics can make playful experiences challenging for teachers to realize (Putnam & Borko, 2000). Pressures around mandated curricula, classroom management, pacing guides, and even knowledge of productive mathematical play contexts can make it difficult for elementary teachers to take up mathematics in playful ways in their classrooms. Research has also demonstrated that primary grade teachers find it challenging to recognize mathematics in children's free play and to leverage those interactions in formal lessons (Ginsburg & Ertle, 2008). To make the context even more challenging, children in the primary grades are generally receiving fewer and fewer opportunities to play in school, even as researchers recognize the academic, social, and emotional benefits of play (Burson & Castelli, 2022).

Given the benefits of mathematical play as well as the challenges of putting it into practice, professional development around math and play seems like a productive path to support primary grade teachers; however, few models for professional development aimed specifically at promoting playful learning exist. In an effort to figure out what transformational professional development around mathematics and play might look like, our research team has spent a year working with kindergarten educators at a public charter school in a southern city. This work included a weeklong workshop in the summer to introduce the idea of mathematical play, four daylong planning workshops throughout the year, the video recording of four weeks of play-based mathematics lessons taught throughout the year, and video clubs based on those play-based lessons three times over the year.

This paper focuses on the week of summer PD and our efforts to build teachers' understandings of what playful mathematics might look like in their classrooms. We explore what playful mathematics learning looked like for teachers, and how our design of activities seemed to support—or thwart—their engagement in an effort to describe the characteristics of playful PD in mathematics.

Literature Review

In order to identify whether or not the activities in our PD promoted playful engagements in mathematics, we turned toward the broader literature on play. Scholars have studied play across the human lifespan, in a variety of social contexts, and even in non-human species. Burghardt (2011) provides general characteristics of play, intended to be applicable across mammal species. He argues that it is pleasurable, functional (doing something for those engaged in the play), different in some way from more serious activities, often repeated, and typically initiated in the absence of stress. Lifter and Bloom, who focused on humans, defined play as consisting of "spontaneous, naturally occurring activities with objects that engage attention and interest" (1998, p. 164). Brown (2009, p. 17) include many of the same characteristics of play but add that play inspires a "diminished consciousness of self" and an "improvisational potential."

Although adult play (in both humans and animals) has been studied less than child play, Elkind (2007) has argued that tinkering with materials offers adults opportunities to develop both creativity and perseverance and Brown and Vaughn (2009) suggest that including play in adults' work lives makes people happier and more productive.

In relation to mathematical play, Oughton and colleagues (2022) have noted similarities between their own play with mathematics as research mathematicians and the engagements of preschool children engaged in play-based mathematics, such as free exploration of materials and discussion with peers to explore mathematical ideas. To guide our analysis, we considered a task to be *playful* in our PD if it contained multiple features of play identified by scholars (e.g., pleasurable, functional, or engaging, non-serious, improvisational). We considered a task *mathematically* playful if it also invited teachers to think more deeply about some aspect of mathematics (e.g., magnitude, comparison, cardinality, similarity, rotations, geometric vocabulary, proportional reasoning, etc.).

Context

The data for this paper comes from a week-long professional development with kindergarten teachers at Strong! Elementary, a public charter school in a mid-sized Southern United States city and situated in a racially and economically diverse neighborhood. The larger research team, which all three authors are part of, is engaged in a multi-year partnership with Strong!, with the larger goal of implementing more mathematical play into teachers' classrooms. This data is from the very beginning of the project, in the summer of 2022.

Four kindergarten teachers participated in this professional development: Ms. Conway and Ms. Lane, two lead kindergarten teachers, and Ms. Nelson and Ms. Clarkson, their respective assistant teachers. The PD was led primarily by the second author and occasionally by other members of the team.

Over the four days of PD, teachers engaged in a variety of activities, including analyzing videos of playful mathematics lessons in early childhood classrooms and videos of children's mathematical thinking, reading, and discussing articles related to mathematical play, analyzing standards, assessments and curricula, and engaging in mathematical tasks. Our analysis focuses on the mathematical tasks teachers engaged in.

At multiple times throughout the week, teachers engaged in free play with materials designed to support mathematical thinking, such as magna-tiles, art supplies, wooden blocks, and Cuisenaire rods. During two different 30-minute blocks, teachers also engaged in guided play with these same materials, where the facilitator gave a specific goal for engagement with the toys, such as making connections between the toys and the kindergarten content standards or thinking about how children in their classrooms might play with particular toys.

Methods and Data

This study draws its data from a larger interpretive project (Erickson, 1986) that seeks to understand both how to support teachers in designing playful mathematics experiences as well as how children engage in mathematics through play. For the current study, we used case study methods (Flyvbjerg; 2006; Stake, 1995) to create contrasting critical cases of enacted mathematical tasks to examine both the characteristics of the tasks in relation to each other as well as differences in the quality of the teachers' engagement in the tasks.

During the weeklong PD, multiple cameras were used to film interactions. A swivel camera was used to record whole-group sessions. During small group activities, cameras were typically mounted at the small tables where partners worked.

Data for this project included the videos taken during the week, field notes taken by graduate student observers, video recorded interviews with teachers at the end of the PD, and written documents used in the PD.

We began analysis by drawing on the fieldnotes and daily PD agendas to identify mathematical tasks that were designed to support teachers in engaging in mathematics (in contrast to activities such as analyzing videos or standards). We found eight distinct mathematical tasks, each lasting 20 to 30 minutes, across the four days of PD. These ranged from episodes of free play with mathematical games and toys to tasks more closely directed by the facilitator.

We then used the video to code each of these tasks for the features of play identified in the theoretical framework and for the mathematical content present. We had expected two activities in particular to be noticeably more productive for supporting the teachers in engaging playfully with mathematics; however, we found that only one of these two activities had significant features of both play and mathematical engagement in the teachers' participation when it was enacted.

As a result of this finding, we engaged in a closer analysis of these two contrasting critical cases that included repeated viewings of the videos, written memos, and conversations among researchers. The analysis below briefly describes the landscape of mathematical tasks from the PD and then focuses on the two activities we had expected to be most successful in promoting both play and mathematical engagements: Pattern Blocks (which we did find to have many features of play and to promote mathematical engagements) and Create-a-Monster (which we found to have many fewer characteristics of play and mathematical engagements, despite our expectations to the contrary).

Findings

Two of the eight mathematical tasks during PD involved free play with carefully selected toys and games. Analysis showed that free play tasks tended to be playful but not mathematical (as represented in the table below). During free play, mathematical ideas were rarely discussed. Conversations often veered toward personal lives or to broader challenges of teaching. However, free play tasks did have characteristics of play. Teachers laughed, chose to work with the materials most interesting to them, and seemed to find genuine pleasure in the activities, such as painting a watercolor landscape, as evidenced by their desires to finish the tasks they had chosen and to go back to them during breaks.

In some guided play activities, there were fewer conversations as teachers took notes or worked on their own, or conversations were muted, such as when two teachers discussed the opportunities for practicing one-to-one correspondence and cardinality as they played a game of Hi Ho Cherry-O. In this case, teachers discussed mathematical ideas relevant to kindergarteners, agreed the game would be playful for their students, but did not seem (unsurprisingly) to find the game playful themselves. The table below locates four sample activities from the PD on axes representing the depth of the mathematics and playfulness that we identified in each activity based on our analysis. These four activities were chosen as exemplars. The following section goes into more depth about the features and enactment of the Pattern Block and Create-a-Monster activity, in order to make explicit characteristics of mathematically playful PD.

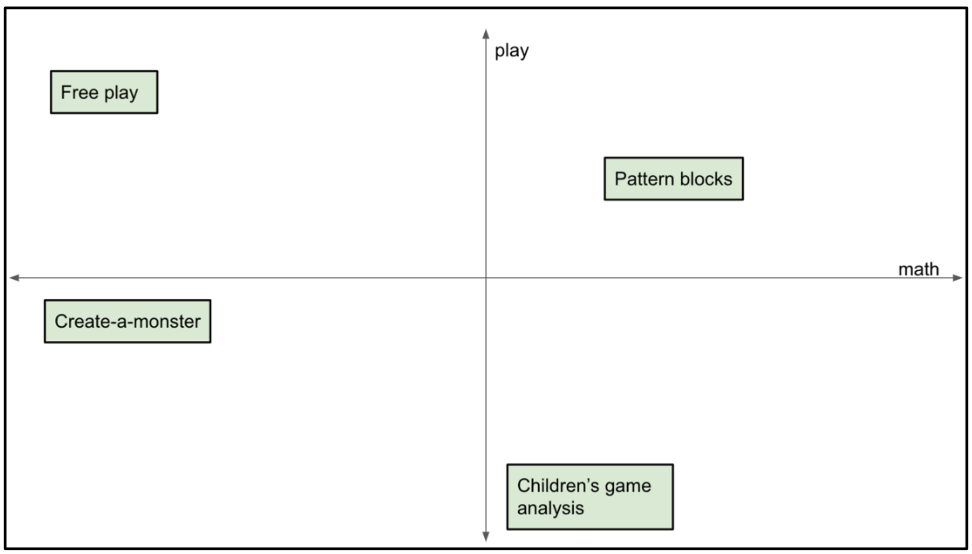

Figure 1: Tasks During PD Organized by Playfulness and Mathematical Learning for Teachers

While the free play activities did not reveal high levels of mathematical engagement and the game analysis did not reveal high levels of playfulness, these findings were expected. The free play activities were intended to provide some of the social and emotional benefits of play and the children's game analysis was intended to support teachers in thinking about how to encourage their children's playful engagement with mathematics. So, while they were not coded high on both scales, they did achieve the intended purpose of the facilitator. However, the other two activities, Pattern Blocks and Create-a-Monster, were intended to provide teachers with the opportunity to experience playful mathematics as learners.

The "Critical Case" Activities

In the "Create-a-Monster," activity, teachers, working in pairs, were invited to use any measuring device they chose (links, ribbons, rulers, etc.) to measure their arms, legs, torso, and head to create a monster twice as large as themselves. They could also choose whether to make the representation 2D or 3D. The mathematical goal was to explore measurement, including units and estimation, as well as proportional reasoning. We conjectured that the creativity involved in the design of the monster and in the variety of approaches to solving the measurement task would support mathematical play. In addition, we felt that the choice of making a monster twice as big would help the teachers see the task as potentially possible with their kindergarteners (perhaps with some modifications), which would also increase their engagement.

The second activity, Pattern Blocks, involved working in pairs. One person used pattern blocks to create a design that was hidden behind a divider, and then explained to a partner how to recreate the design without showing the design itself. After the partner completed their replica, the divider was lifted, and the images compared. The mathematical goals of the activity were to explore geometric vocabulary and attributes, language about position, and spatial reasoning. No constraints were placed on the number or type of blocks that could be used except that each block had to be touching another. We conjectured that this lack of constraint would make the task both playful and cognitively demanding for the teachers, while also allowing them to imagine how imposing additional constraints (e.g., limiting the number of blocks) would make the same task manageable for kindergarteners.

In our analysis of the two mathematical activities, we found that the Pattern Blocks activity became highly playful for the teachers and invited multiple mathematical conversations. By comparison, Create-A-Monster did not become as playful as we hoped, despite opportunities for creative expression, social engagement, and invitations to silliness and that mathematical conversations were relatively limited.

Create-a-Monster. Teachers seemed to find the Create-a-Monster task both mathematically and creatively uninteresting. While Ms. Conway initially seemed to attempt making the monster activity playful by asking her partner teacher, Ms. Nelson, about creating the arms of the "monster," Ms. Nelson did not take up the invitation.

Ms. Conway: Are they gonna be, like, person-like arms or are they gonna be, like, monster-like arms? How should I cut them?

Ms. Nelson: I think however you want.

This response from Ms. Nelson could be taken to signal a lack of engagement in the activity, either as a result of the relative simplicity of the math being used or a lack of interest in the ultimate goal of creating a monster. Ms. Conway seemed to take the feedback as meaning this activity was not a time for silliness, and decided to create human arms and would also go on to create "person-like" features for the legs, head, and torso.

There was some novelty seen at the beginning of the activity, when Ms. Conway initially cut out the first arm and seemed amused at how long it was:

Ms. Conway: (Holding up the length of the paper arms) Look at these arms. (chuckles) That's how long the arm is.

Ms. Nelson: (Laughs, begins measuring her own head independently)

However, the "twice as long" novelty seemingly wore off fairly quickly, and they went on to complete the task without even taping the "monster" together.

The other set of teacher partners, Ms. Lane and Ms. Clarkson, worked mostly independently on separate body parts, partially in silence, and partially engaged in casual, non-mathematical conversations. The independent nature of their experience with this activity and the lack of mathematical conversations suggests a lack of mathematical interest around this task. Additionally, the task of making a monster did not seem to inspire a playful interest. Just like the other pair, they created a large person, who did not have any "monster-like" characteristics.

Pattern Blocks. In contrast, the Pattern Block activity, seemed to create many playful engagements as well as mathematical conversations. In her group, Ms. Lane was the first to build and describe what she made. Yet, when Ms. Conway was trying to interpret her directions, she ran into trouble almost immediately: Ms. Lane's directions called for a parallelogram, but in the set of pattern blocks, there were three different parallelograms to choose from. In the clip, Ms. Conway paused for a moment, looking between the choices she had to recreate the image being described to her, before deciding to use one parallelogram over the others.

Another piece of evidence that this was a mathematically demanding task for the teachers was that both sets of teachers were not able to successfully recreate their partners' images on the first try. In both partner groups, teachers squealed and laughed when they raised their folders to see the differences in their designs, showing pleasure in the process even after a failed attempt. In addition, both groups were eager to play again, demonstrating a genuine engagement. Additionally, after their reveals, the teachers discussed new vocabulary or strategies that they needed to draw on when playing this game in order to succeed.

During the pair's initial reveal, Ms. Conway brought up the presence of multiple parallelograms.

Ms. Conway: That's the right one though! Because there were also these (Picks up an alternative parallelogram) and I was like oh, no which… which one?

Ms. Lane: (smiling) Ohhh yeahh… okay

She then brought up the importance of how to orient a trapezoid within the picture to connect with a hexagon in the second round:

Ms. Conway: I should have specified, like this (*pointing to one edge of the trapezoid she used to connect to the hexagon*) instead of this (*pointing to the different edge of the trapezoid that Ms. Lane used to connect to the hexagon.*

In the next round of play, teachers used, more mathematically precise language and were more successful in their recreations.

A simple game of putting geometric shapes together while following directions from your partner became a site both for mathematical engagement and play. This was reiterated by Ms. Lane during a reflection, where she cited the reveal as being joyful, even when they got the shapes wrong. Adding another layer of their engagement, the activity also invited teachers to consider ways in which the game could be modified so that their students could play, such as starting with fewer shapes.

Discussions and Conclusions

In our analysis, we found that for adults, the appropriate level of mathematical challenge was an important feature in creating a playful math environment. Interestingly, there was no trade-off between "math" or "fun." Instead, we found that the activity that was more mathematically challenging and interesting was also more playful, suggesting that future PD activities should be planned with a focus on creating mathematically interesting tasks for teachers, rather than on demonstrating that the tasks could also be used with kindergarteners. Also, we recognized that challenging mathematical content included new mathematical practices. Naming shapes is not what makes the pattern tiles mathematically interesting for teachers, but learning how to communicate about shapes to a partner who cannot see becomes a complex venture with many parts. Finally, we recognize that tasks alone do not carry activity. For brevity, we do not explore the norms that allowed for exploration and a task with a high failure rate to be experienced as playful and enjoyable, but further work will explore these conditions.

In conclusion, we found our task that promoted both more playfulness and more mathematical engagement was more challenging mathematically, invited laughter and surprise and was seen as interesting to adults. Both tasks used interesting materials, allowed for social engagement, made room for improvisation, and had explicit connections between the task done in PD and a potentially similar task that could be done in kindergarten. However, only the Pattern Block task seemed to promote actual meaningful mathematical engagement and playful interactions among the teachers.

The Pattern Block activity required teachers to engage in discussions about shape orientation, relationships between shapes, and connections to the real world. This task was not just about naming shapes but rather about relationships, composing, and then relaying that information without any visuals. The surprise teachers felt in seeing that their designs did not match provided them with pleasure and created a functional desire to repeat the activity to get it right. The Create-A-Monster activity, while in many ways had the potential to be playful, did not inspire visible pleasure or desire for deep engagement or improvisation in the teachers. This seemed to be in part because the teachers did not find creating a monster to be serving a meaningful function in their lives and because the mathematical task of doubling a person did not provide a mathematically interesting challenge. The teachers' engagement in the activity was evidently less playful, and the teachers did not show a desire to continue with the task.

This work has implications for PD as it provides beginning guidance for designing playful mathematical tasks for PD. In addition, it suggests the need for further research on what it takes to create playful learning environments in PD and preservice classrooms, particularly focused on differences between child and adult learners.

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References

Brown, S. L. (2009). Play: How it shapes the brain, opens the imagination, and invigorates the soul. Penguin.

Burghardt, G.M. (2011). Defining and recognizing play. In A. Pellegrini (Ed.), Oxford handbook of the development of play (pp. 9–18). New York, NY: Oxford University Press.

Burson, S. L., & Castelli, D. M. (2022). How Elementary In-School Play Opportunities Relate to Academic Achievement and Social-Emotional Well-Being: Systematic Review. Journal of School Health, 92(10), 945-958.

Casey, B. M., Andrews, N., Schindler, H., Kersh, J. E., Samper, A., & Copley, J. (2008). The development of spatial skills through interventions involving block building activities. Cognition and Instruction, 26(3), 269-309.

Elkind, D. (2007). The power of play: How spontaneous, imaginative activities lead to happier, healthier children. Da Capo Lifelong Books.

Erickson, F. (1986). Qualitative methods in research on teaching. In M. Wittrock (Ed.), Handbook of research on teaching (3rd ed., pp. 119-161). New York: Macmillan.
Flyvbjerg, B. (2006). Five misunderstandings about case-study research. Qualitative inquiry, 12(2), 219-245.
Ginsburg, H. P., & Ertle, B. (2008). Knowing the mathematics in early childhood mathematics. Contemporary perspectives on mathematics in early childhood education, 1(3), 45-66.
Henningsen, M., & Stein, M. K. (1997). Mathematical tasks and student cognition: Classroom-based factors that support and inhibit high-level mathematical thinking and reasoning. Journal for Research in Mathematics Education, 28(5), 524-549.
Lifter, K., & Bloom, L. (1998). Intentionality and the role of play in the transition to language. In A.M. Wetherby, S.F. Warren, & J. Reichle (Eds.), Transitions in prelinguistic communication (pp. 161-195). Baltimore, MD: Paul H. Brookes Publishing Company.
Oughton, R., Nichols, K., Bolden, D. S., Dixon-Jones, S., Fearn, S., Darwin, S., ... & Townsend, A. (2022). Developing 'deep mathematical thinking' in geometry with 3-and 4-year-olds: a collaborative study between early years teachers and university-based mathematicians. Mathematical Thinking and Learning, 1-20.
Putnam, R. T., & Borko, H. (2000). What do new views of knowledge and thinking have to say about research on teacher learning? Educational Researcher 29, 1(4-15).
Seo, K. H., & Ginsburg, H. P. (2004). What is developmentally appropriate in early childhood mathematics education? Lessons from new research. Engaging young children in mathematics: Standards for early childhood mathematics education, 91-104.
Siegler, R. S., & Ramani, G. B. (2009). Playing linear number board games—but not circular ones—improves low-income preschoolers' numerical understanding. Journal of educational psychology, 101(3), 545.
Stake, R. E. (1995). The art of case study research. Sage.
Stein, M. K., Smith, M. S., Henningsen, M. A., & Silver, E. A. (2000). Implementing standards-based mathematics instruction: A casebook for professional development. New York: Teacher College Press.
Wolfgang, C., Stannard, L., & Jones, I. (2003). Advanced constructional play with LEGOs among preschoolers as a predictor of later school achievement in mathematics. Early Child Development and Care, 173(5), 467-475.