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Play-Inspired Organic Differentiation in Early Math

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Abstract: As part of a larger project to explore the possibilities for children to learn mathematics in play, we examined how opening up a pattern block activity provided space for children to differentiate their interactions. The limiting nature of the original task would have stopped children from demonstrating what they could do and might explore. Using Bishop's (1988) fundamental mathematical activities as our codes, analyzed video of eight children engaging in pattern block play revealed how they organically differentiated, pushing learning opportunities beyond the scope of the original lesson.

Situating the problem

Revising a lesson to invite children to play with mathematics and take agency provides them with opportunities to demonstrate mathematical understanding beyond what the lesson goals require. In a spatial reasoning activity modified to be more playful, we found that children's varied engagement that derives from a child's agency, rather than a different activity put forth by the teacher, is what we call 'organic differentiation'. This engagement can range from children participating in ways that align with the expected goals for the task (e.g., placing the pattern blocks on the puzzle) to a demonstration of pushing their participation beyond expectations in a challenging or new way (e.g., using pattern blocks to create a new design). Organic differentiation may allow children agency to approach activities in ways that align with their own experience, interests and expertise. As part of a larger study of designing classrooms that support children's mathematics learning with play, we explored the questions:

1. How do playful pattern block activities support children's engagement in mathematics?
2. How do open-ended play-based activities provide opportunities for organic differentiation?

Conceptual framework

Vygotsky (1978) viewed human development as a socially-mediated process; informed by social experiences/ interactions (including play). When considering learning opportunities, the children operated in their zones of proximal development (ZPD); working in spaces they were familiar but also trying new things. As a lens to examine children's engagement with the mathematical activity, we drew on the work of Bishop (1988) who identified six fundamental activities of mathematics (counting, locating, measuring, designing, playing, and explaining) that he found to be universal and necessary for mathematics. These fundamental activities enable us to see what mathematics is around to be learned, what mathematics children are doing, and how to label those practices as such.

Methods

These data are from video recordings of two small groups of kindergarten children. Analysis focused on a guided play activity: pattern block puzzles where children were provided with a large box of pattern blocks and several templates to create shapes with the pattern blocks. From Bishop's (1999) six fundamental activities, we collectively identified "designing" and "locating" as the primary practices children engaged in. Using video analysis software, we coded each video multiple times, focusing on individual children each time. Descriptive codes that characterize the ways children participated in locating and designing guided the narratives we wrote for each child. We then compared narratives and codes and discussed children's engagement across groups.

Findings

Our analysis shows that the children engaged differently with the pattern blocks even when given similar instructions and materials for the guided play math center. We argue that these children's actions, the mathematical practices they engaged in, and their engagement supports our finding that this playful activity afforded the children the opportunities to self-differentiate in an organic way. To characterize the children's engagement, we identified four common patterns of play: the rotators, the aligners, the designers, and the duplicator. Although some children participated in practices that were used across the groups (e.g., rotating shapes), we identified these groups to showcase the primary ways the children engaged in mathematical practices.

The Rotators (n=2) would look at the puzzle, select the shapes, and then rotate and slide them to fit together. They participated in the math practice of locating as they actively rotated and slid shapes to fit within the puzzle. The different ways the children did this (in the air or on the paper) and the different goals of rotating (to match the shape or to determine the fit within the puzzle), highlight, even within this group, the ways the children differentiated their engagement with the mathematical practice of locating to be successful with this activity. The Aligners (n=3) made sure each shape fit perfectly on the pattern block puzzles or in line with the other shapes. A key characteristic of this group was their attention to the final product which required that pieces were precisely placed. Making sure that each shape fit perfectly within the pattern-block puzzle, the children would look at the puzzle and then find that shape in the box and place it directly on top of the puzzle in the exact placement. They attended to precision in the placement of each shape by touching it on either side with both hands in order to slowly and more accurately adjust it to fit the puzzle. The Creators (n=2) did not follow the pattern puzzle instead, upon recalling that the teacher had told them, “we are making shapes out of other shapes”, decided to create their own. In their designs, the children attended to symmetry and created patterns using tessellations and symmetrical patterns. The Duplicator (n=1), unlike all other children who either stayed on the pattern block template or completely deviated from it, used the pattern block template as a guide and completed his puzzle off of the paper itself. To do so, he first sorted all of his shapes and then using the snake pattern block puzzle as a reference duplicated the puzzle on the desktop next to it. During this process he continued to use rotating and sliding to ensure that the correct sides of each side aligned with one another.

Discussion, conclusion, and implications

Play can afford children opportunities to organically differentiate their engagement with mathematical activities. While differentiation is often thought of as a way that teachers can create various access points for children during lessons (Goddard & Kim, 2018), we saw organic differentiation through the ways the children naturally engaged with the materials differently and participated in different mathematical practices. The children used the same materials, but the ways they engaged were very different. The findings are are purposefully presented, not to suggest linear learning trajectories, but to highlight the complexity and fluidity of children’s engagement during playful activities when they have the autonomy to engage with materials.

The findings have implications for teaching. Playful activities where children can engage with materials with autonomy can be spaces where children can naturally challenge themselves to push their learning further. Rather than providing constrained tasks with explicit standards in mind, by opening up an activity we found that children went well beyond the intended mathematical goal. Rather than a teacher having to intentionally give each child a different task, the autonomy the children experienced contributed to the children differentiating how they engaged while still staying on task. Teachers can increase students' autonomy by providing spaces for organic differentiation.

References

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