Tips from Practitioners: Cultivating School Communities with Vertical Mathematics Tasks

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This is the story of how a coach used mathematics to cultivate an elementary school community. It began at a faculty meeting where the principal and teachers expressed that they wanted a better community within their school. They wanted students from all grades to know and respect all teachers. They also wanted to build a multi-grade mentoring program. Since the school already practiced Responsive Classroom, one day each month, they used a morning meeting (Kriete & Davis, 2014) that is school-wide to bring everyone together. The entire school met in the cafeteria, soccer field, or gym where they would greet one another, receive a morning message from the principal, hear reports from the student government, and engage in a school-wide activity. The math coach used an inclusive process to infuse a multi-grade math task during these monthly morning meetings. The result was a collaborative, fun, and respectful school community.

Planning an Accessible Task.

The two major hurdles that work against a school-wide math tasks during the morning meetings were time and rigor, since the meeting was only ten minutes long, and children had varied math abilities. The math coach reviewed the curriculum and examined multi-grade standards (see Table 1). The math coach chose patterns to use for the vertical math task (see Figure 1). The math coach evaluated a potential math task using Wolf's (2015) 6 characteristics of rich tasks.

Grade Level (SOL)	Standard Related to Patterns
Pre-K	**Identify and extend repeating patterns through clapping, and singing.**
Kindergarten (K.13)	Identify, **describe**, extend, **create and transfer repeating patterns.**
First Grade (1.14)	Identify, **recognize**, describe, extend, and transfer **growing** and repeating patterns.
Second Grade (2.16)	Identify, describe, create, extend, and transfer **patterns found in objects, pictures, and numbers**
Third Grade (3.16)	Identify, describe, create, extend, and transfer patterns found in objects, pictures, numbers, and **tables**.
Fourth Grade (4.15)	Identify, describe, create, and extend patterns found in objects, pictures, numbers, and tables.
Fifth Grade (5.18)	**Describe and express the relationship of number patterns** found in objects, pictures, numbers, and tables
Accelerated Fifth Grade (6.14)	**Represent a practical situation with a linear inequality in one variable**

Table 1. Standards related to patterns by grade (Virginia Department, 2016).

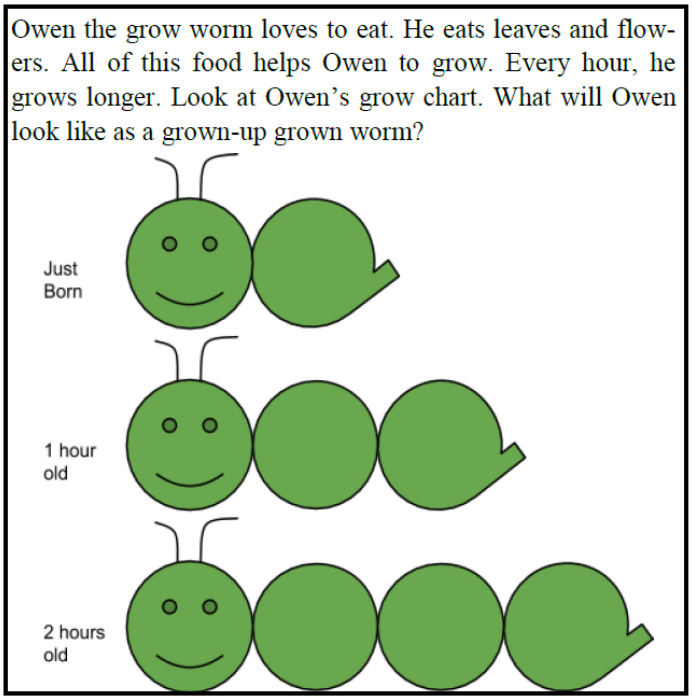

Figure 1. Vertical Math Task.

Math Grade-Level Meetings.

To facilitate this process, the school introduced weekly grade-level meetings with the coach. The coach previewed the vertical task to the teachers for each grade, PK – 5. Initially, the upper elementary teachers hesitated to engage in the task because they thought it was vague and incomplete, so the coach challenged them to find 15 different ways to solve the problem. This challenge inspired their competitive nature, and the teachers developed many more solutions and representations. Each team of teachers showed unique, grade-level strategies and explanations. The kindergarten teachers, whose standard focused on repeating patterns, not growing patterns, used the task as is and found that they could solve the problem using teen numbers (a major

hurdle for this grade) and then color in the grown up grow worm using the repeating patterns (see Figure 2).

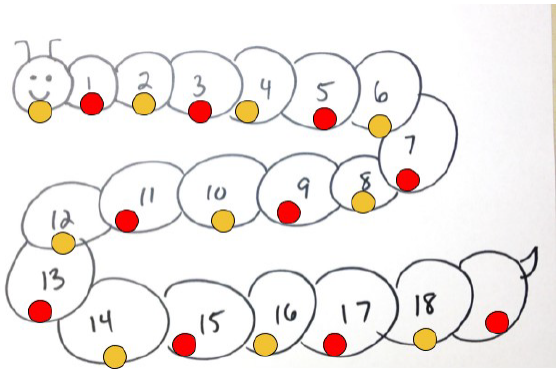

Figure 2. Kindergarten teacher's solution using teen numbers and AB patterns.

The third through fifth grade teachers were perplexed with the question did Owen grow 1 segment (see Figure 3) or 2 segments (see Figure 4)? They produced models, diagrams, and tables to defend their reasoning. Those representations were used to define recursive rules such as add 1 bubble for each hour, and they defined functions such as 2+ number of hours old. This evolved into a discussion about how students will use both representations in middle school when graphing with slope and y-intercept. Finally, the teachers used the slinky worm representation (see Figure 5) to defend the "+1" and "+2" phenomenon and their discussions were recorded (see Table 2). Several teachers recognized the value of using units, because it was both correct to say "Owen grows 1 circle per hour" and "Owen's growth begins with 2 circles plus the number of hours after his birth."

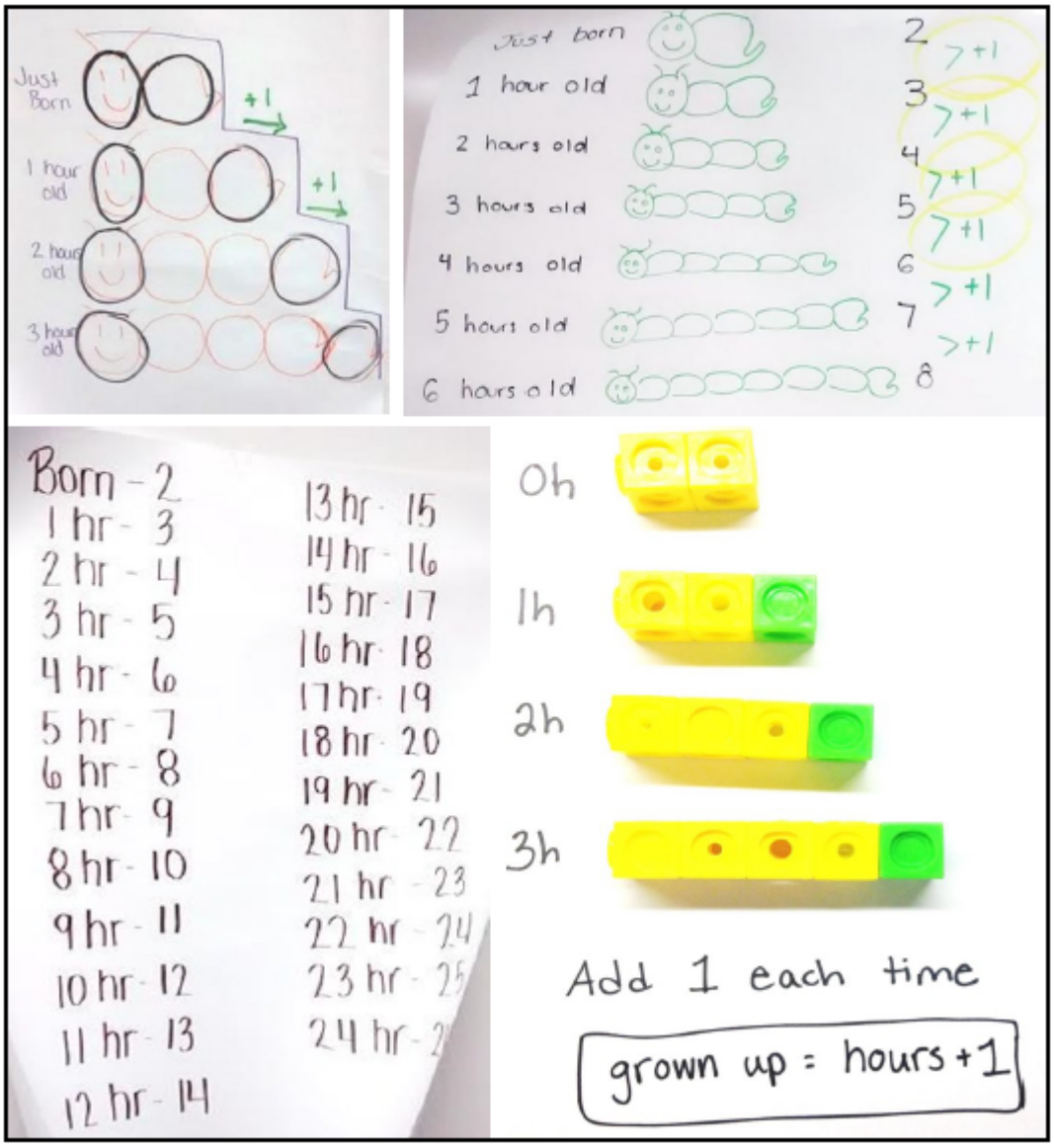

Figure 3. Representations of "+1" growth.

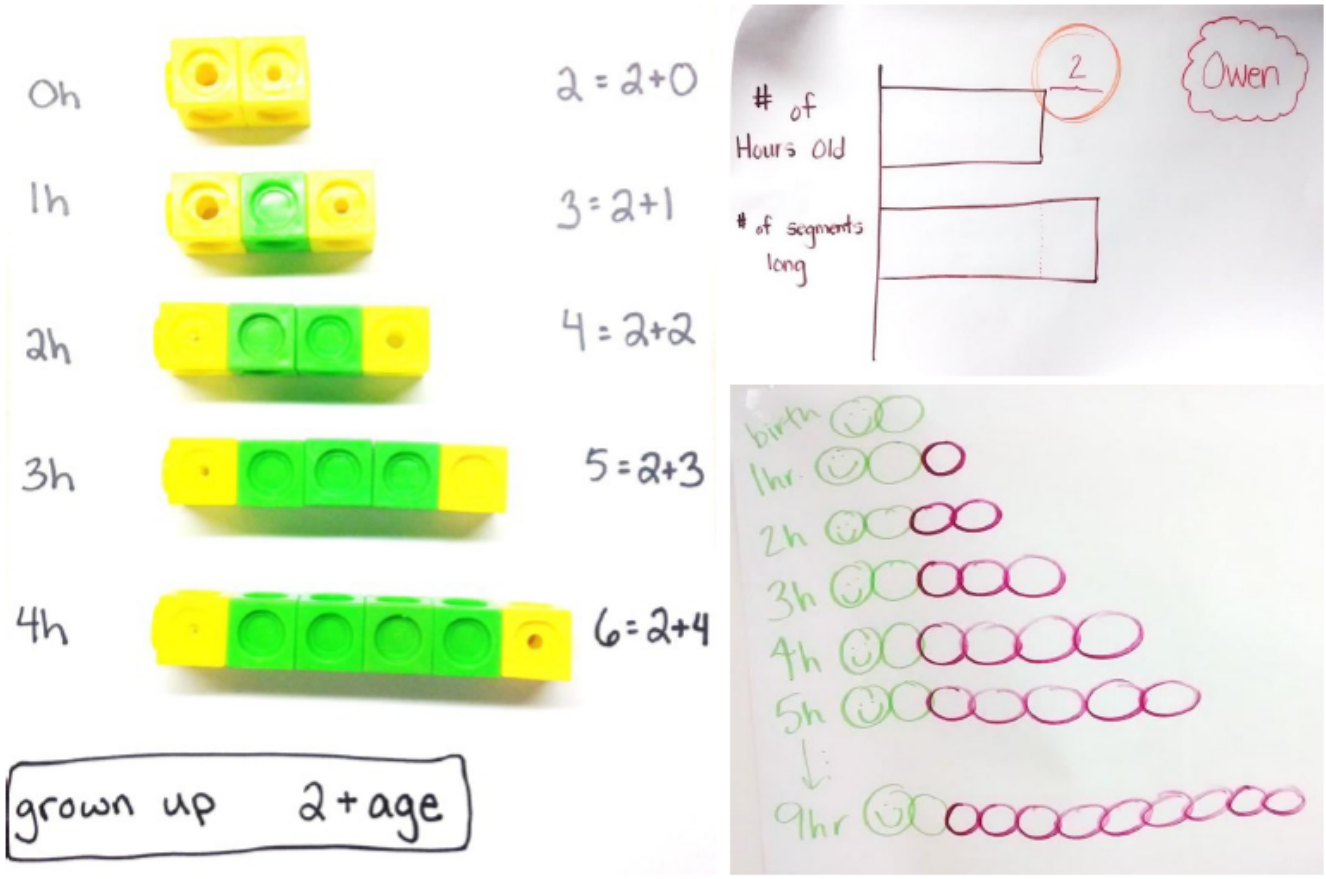

Figure 4. Representations of "+2" growth.

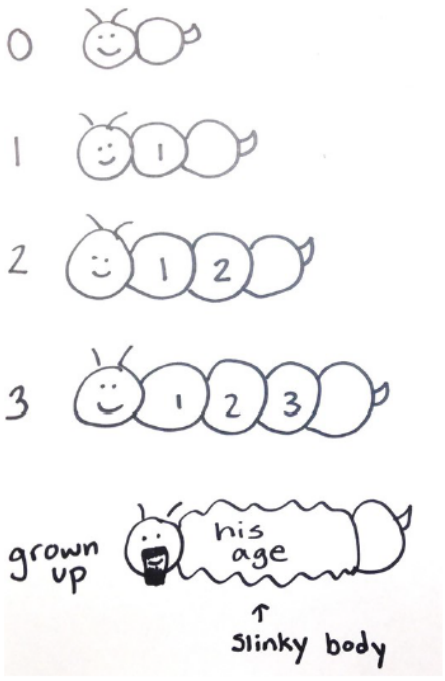

Figure 5. Slinky worm representing both "+1" and "+2" growth.

"+1" growth	"+2" growth
It is +1 because his slinky body increases by 1 each hour. 1 circle per 1 hour Rate of growth Slope	It is+2 because the slinky body is the size of the number of hours and you add 2 more for the head and tail. Start with 2 (head and tail) Starting Point y-intercept

Table 2. Explanation of "+1" and "+2" growth.

After previewing the problem, and engaging in rich mathematical discussions, the teachers were excited to complete the task with their students. However, many were unsure how to conduct a rich mathematical classroom discussion. The coach introduced Smith & Stein's (2011) 5 practices for orchestrating productive mathematics discussions. The grade-level team discussed the importance of anticipating student strategies, selecting and sequencing student presentations and how to ask open ended questions in order to make connections. The teachers created connections maps, a visual web diagram used to plan math discussions (Wills, 2015) for their grade-level (see figures 6-8) and were feeling prepared to facilitate the task in their own classrooms.

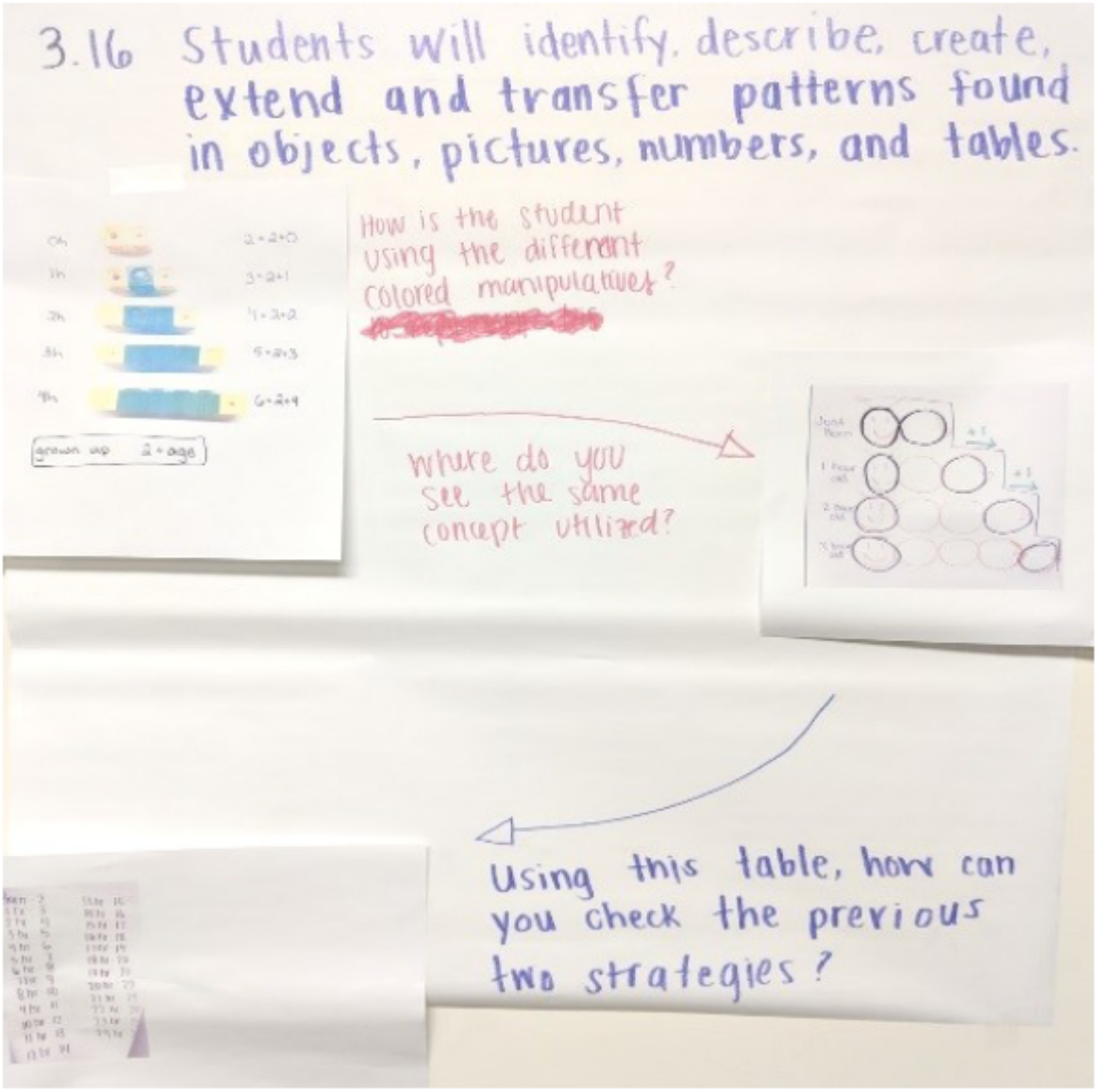

Figure 6. Grade 2 Connections Map.

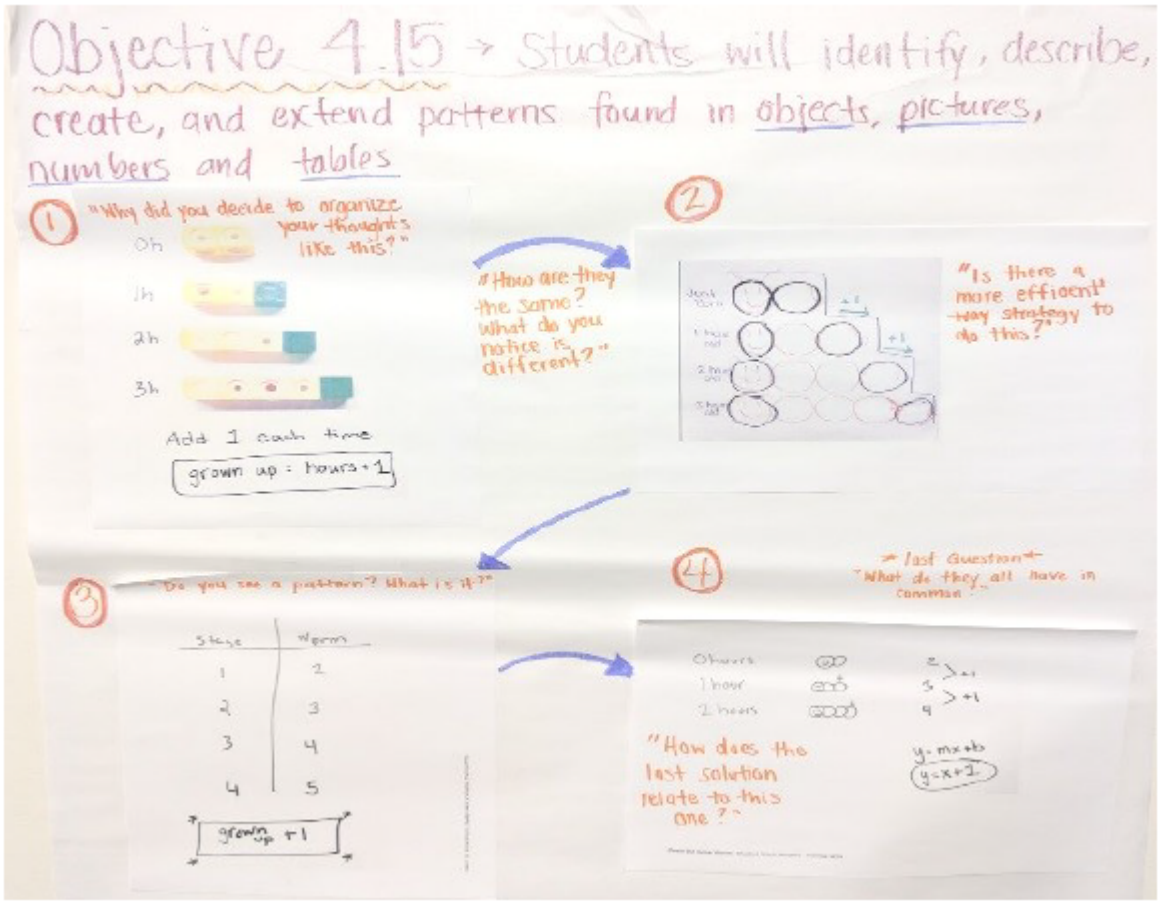

Figure 7. Grade 4 Connections Map.

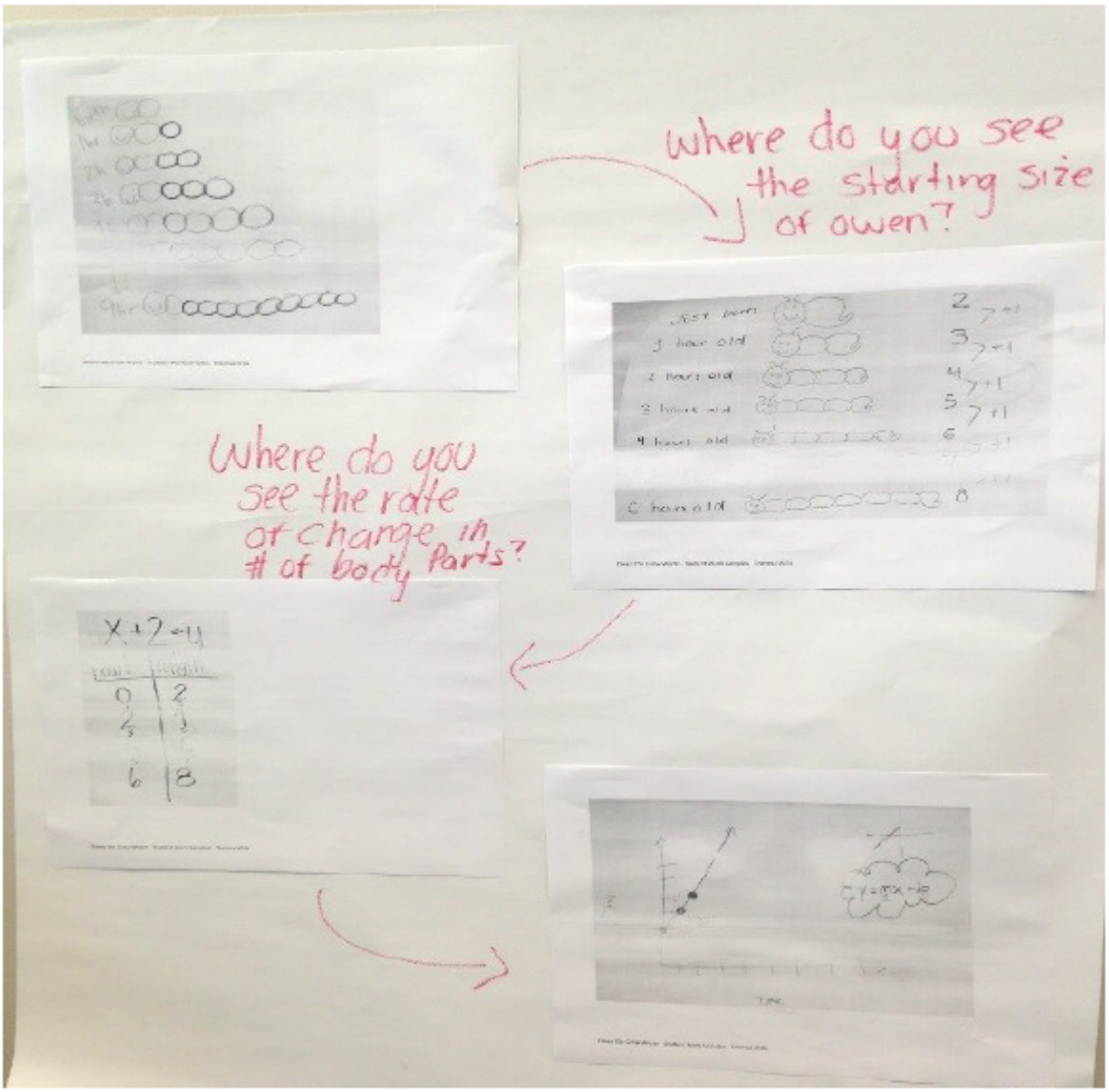

Figure 8. Grade 6 Connections Map.

Later that week, at a school faculty meeting, the coach displayed the connections maps from Pre-K through accelerated 5th grade. As the teachers entered the meeting, they were asked to analyze the connections maps and then engage in a conversation at their mixed grade-level tables. Teachers were surprised to see how "their" problem was applicable to so many different grades. They transferred the ownership of "their" problem from a single grade level to a shared school-wide task.

School-wide Morning Meeting.

Thursday, Week 1: The entire school gathered in the cafeteria and began the morning meeting. Each student and teacher introduced themselves to a new friend, the principal read the morning message, and the student government reported on a new design for the school mascot. Then the vertical math task was unveiled and students began working; some used mental math while others drew diagrams or used manipulatives. Even the teachers engaged with the problem again. After ten minutes of independent followed by collaborative think time, the students were told that they would continue working on the problem during math class.

Classroom Math Time.

Thursday, Week 1: During math class time, the students reread the grow worm problem. Students were given manipulatives, paper, and crayons to use to help them solve the problem. Teachers walked around their classroom asking questions and probing students for understanding. Some teachers engaged students in a math discussion that day, while others chose to engage in discussion the following day.

Follow Up Grade-Level Meetings.

Friday, Week 1: In the grade-level meetings, the coach revisited the vertical math task with the teachers. Each teacher brought several student work samples. The teachers who held a math discussion reported on their experiences and offered tips to those who were planning to do it the next day.

Display Student Work.

Monday, Week 2: At the request of several teachers, each class posted their student work outside of their classrooms. The hallways were filled with colorful grow worms, t-charts and tables, photos of manipulatives, and long worms. The students talked about math outside of the classroom and at lunch. At the end of the day, the children continued to talk about the schoolwide mathematical task.

Mentoring Day.

Friday, Week 2: The coach and principal met and agreed to continue this practice by creating a mentoring day. A schedule was developed such that each grade level could visit a classroom at the next grade level to hear students discuss the problem with one another. For example, Ms. B's third grade class partnered with Ms. M's fourth grade class. The fourth grade students explained their strategies and then the third grade students followed with their explanations. The students were challenged to make connections between the two examples, which they did with various levels of success.

Lasting Impact.

The vertical math task made a lasting impact on the school. The school became a learning community. Teachers and students from different grade levels had a shared problem to solve. The music teacher connected the beats and rhythms to the patterns, and the science lab teacher discovered that some worms live to four years! In the following weeks, students would share facts about worms and growth rates. The friendships that were introduced during the mentoring days continued on the playground.

Conclusion.

This structure of building a school community through a vertical math task involved 1) creating a math problem that is accessible to all grade levels, 2) teacher grade-level meetings to anticipate solutions and align the task with the grade-level standards, 3) introducing the task during a school-wide morning meeting, 4) solving the task in classrooms during math time, 5) teacher grade-level meetings to discuss student work and connections, 6) posting the student work in the hallway, and 7) conducting mentoring partnerships between grade-levels. The process pushed most teachers outside of their comfort zone. At first, many teachers were unsure how their students would respond to this way of thinking but wanted students to take responsibility for their learning. The school continued to use vertical math tasks in the school-wide morning meetings. Today, three years later, the elementary school thrives in cross-curricular and multi-grade math problem solving and discussions.

References

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