Children Who Enjoy Problem Solving

What Children Say about Problem Solving

Over the past ten years, I have documented the comments that children made as they solved a wide variety of problems and as they shared their solutions with their peers in a multiage classroom of first, second, and third graders (see fig. 1). I also have used one-on-one interviews to record children’s comments and reactions to various classroom practices during problem-solving activities. What follows are my findings.

Young children want to solve problems, and their enjoyment of problem solving increases when children can solve problems in ways that make sense to them. Jose, Amber, and other children have taught me the importance of independence in the process of becoming a problem solver. Seven-
FIGURE 1

Some of the types of problems used in the author’s classroom

<table>
<thead>
<tr>
<th>Nonroutine story problems</th>
<th>For examples, see the “Problem Solvers” section in this and past issues of Teaching Children Mathematics.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Problems within a story</td>
<td>- Without counting the dots on each page, how many dots are in the book Ten Black Dots by Donald Crews?</td>
</tr>
<tr>
<td></td>
<td>- After reading Slower Than a Snail by Anne Schreiber and Larry Daste, make a list of comparisons for “I’m faster than ... but I’m slower than ...,” “I’m taller than ... but I’m shorter than ...,” and “I’m heavier than ... but I’m lighter than ...”</td>
</tr>
<tr>
<td>Problems based on the context of the classroom</td>
<td>- How many pizzas do we need to buy so that everyone in our classroom gets 2 slices of pizza, if the pizzas are cut into 6 slices?</td>
</tr>
<tr>
<td></td>
<td>- Jacob can walk around the track in 5 minutes. Andrea can walk around the track in 4 minutes. It is 900 feet around the track. If Jacob and Andrea start at the same time, how far ahead of Jacob will Andrea be when she finishes walking around the track 1 time?</td>
</tr>
<tr>
<td></td>
<td>- First, they placed three rhombi on top of a hexagon so that the surface area of the rhombi matched the surface area of the hexagon.</td>
</tr>
<tr>
<td></td>
<td>- Next, they repeated this action three times.</td>
</tr>
<tr>
<td></td>
<td>- Finally, they counted the total number of rhombi used: twelve.</td>
</tr>
</tbody>
</table>

One second grader, however, took two trapezoids and said, “Well, these two make a hexagon, but a trapezoid is really one rhombus and one triangle hooked together like this [see fig. 3]. So if you have two of them [trapezoids] you really got three rhombuses, because you count the two [rhombi] you already have and then you hook the two triangles together, and that makes another one [rhombus], and so you have three of them [rhombi] in all. But you aren’t done, ‘cause there are really eight of them [trapezoids], so you do it again and again and again and that makes twelve rhombuses.”

Young children want to learn from their mistakes, and their enjoyment of problem solving increases when children know that mistakes will be used as stepping stones to new learning. Chris, Courtney, and other children have taught me the role that mistakes can play in the process of becoming a problem solver. Chris, age 7, said, “Sometimes you’ve got to be wrong so the next time you can be right.” “At least I am trying, unlike some kids who don’t write anything on their paper and say they don’t get it,” said Courtney, age 6.

I used to teach mathematics with drill and practice exercises, and I viewed mistakes as signs of children’s failure to remember information or apply information correctly. Now, however, when a child’s solution contains an error, I try to remember a story about inventor Thomas Edison. He tried two thousand times to invent the electric light bulb before finally succeeding. A young reporter once year-old Jose said, “I know what I know. I get messed up when I try to do problems the way you [the teacher] want.” Amber, age 8, said, “The ways on the [problem-solving strategies] chart are hard to remember, and most of the time I get mixed up and I can’t decide which one to use, especially when it’s a hard problem.”

In the past, I tried to teach problem solving by showing children how to solve particular types of problems in a prescribed manner with computation algorithms or traditional problem-solving strategies such as guess and check, work backward, look for a pattern, and so on. Now I encourage children to solve problems in ways that make sense to them, and I try to help them acquire the habits, behaviors, and dispositions of a problem solver, such as patience, perseverance, and a positive attitude. As I learned to trust in children’s natural problem-solving abilities, the children learned to trust in themselves and developed the self-confidence they needed to become successful problem solvers.

When children are given the opportunity to solve problems “their way,” they take great pride and pleasure in developing their own strategies, instead of simply practicing strategies that adults have shown them. Children can not only create solutions to problems that resemble traditional problem-solving strategies but also invent ways of solving problems that reflect the ingenuity and creativity of their young minds. One day while exploring various relationships between different pattern blocks, I posed the following problem: “How many rhombi will it take to balance four hexagons?” Most children in the classroom solved the problem in the following manner, shown in figure 2:

1. First, they placed three rhombi on top of a hexagon so that the surface area of the rhombi matched the surface area of the hexagon.
2. Next, they repeated this action three times.
3. Finally, they counted the total number of rhombi used: twelve.
asked him how it felt to fail so many times. “I never failed once,” Edison said. “It just happened to be a two thousand-step process.” Similarly, children make a lot of mistakes when they solve problems, especially when they solve problems in ways that make sense to them, but mistakes are a valuable part of the problem-solving process. Both teachers and children can benefit from mistakes in the following ways:

- Children can use mistakes as learning tools to correct errors in their logic or to refine their understanding of mathematical concepts.
- Teachers can use children’s mistakes to gain insights into why children make errors, gather information about what children already know, and extend and expand children’s current knowledge.

In his book titled *Teaching with the Brain in Mind*, Eric Jensen states, “The single best way to grow a better brain is to engage in challenging problem solving. Surprisingly, it doesn’t matter to our brains whether we come up with the right answer or not: the neural growth happens because of the process, not because we have found the correct answer” (Jensen 1998). This is not to say that the correct answer does not matter, or that the process used to solve a problem is more important than the final answer. Answers do matter, especially in mathematics. Answers are only part of the solution process, however, and they usually represent the end product of many previous steps. In my experience, the children who become the most flexible and adept problem solvers are those who are able to learn from their mistakes. Therefore, I constantly try to reassure children that their mistakes are a natural and necessary part of learning; they should embrace mistakes rather than avoid them. Convincing children of this is not always easy because some of them see mistakes as signs of failure, especially if they have experienced mathematics only through drill and practice exercises.

Although mistakes are important to children’s learning, that children are acknowledged for the things they do well is equally important. Even when a child does not find the correct answer, his or her solution may reveal a genuine understanding of the mathematics embedded in the problem (see fig. 4). As Brandi, age 6, observed, “When I make a mistake, don’t just tell me what I do bad—tell me what I do good.” I also have come to realize that children often make mistakes simply because they think differently from adults and use different criteria to determine the important features of a problem. For example, some young children will arrive at an answer to the following problem that most adults would consider incorrect, and the children will justify their answer with a form of logic that most adults would find difficult to understand:

> I put 15 red cubes, 9 blue cubes, and 3 yellow cubes in a bag and shake them. Then I reach in the bag and, without looking, take 1 cube out. What probably is the color of the cube that I took out of the bag?

Surprisingly, some young children will answer “Yellow.” The reason that they give for choosing this color is even more surprising: “Because the yellow ones are on the top.” These children seem to think that the cubes maintain their relative positions in the bag even when they are shaken, and because the yellow cubes were placed in the bag last, they are “on top” and therefore have a greater chance of being picked. To most adults, the number of cubes of each color is the important feature of learning, that children are acknowledged for the things they do well is equally important. Even when a child does not find the correct answer, his or her solution may reveal a genuine understanding of the mathematics embedded in the problem (see fig. 4). As Brandi, age 6, observed, “When I make a mistake, don’t just tell me what I do bad—tell me what I do good.” I also have come to realize that children often make mistakes simply because they think differently from adults and use different criteria to determine the important features of a problem. For example, some young children will arrive at an answer to the following problem that most adults would consider incorrect, and the children will justify their answer with a form of logic that most adults would find difficult to understand:

> I put 15 red cubes, 9 blue cubes, and 3 yellow cubes in a bag and shake them. Then I reach in the bag and, without looking, take 1 cube out. What probably is the color of the cube that I took out of the bag?

Surprisingly, some young children will answer “Yellow.” The reason that they give for choosing this color is even more surprising: “Because the yellow ones are on the top.” These children seem to think that the cubes maintain their relative positions in the bag even when they are shaken, and because the yellow cubes were placed in the bag last, they are “on top” and therefore have a greater chance of being picked. To most adults, the number of cubes of each color is the important feature of
Young children want to communicate their solutions to problems with others, and their enjoyment of problem solving increases when children can share and discuss their solutions with peers. Tanisha, Shanna, and other children have taught me the importance of discourse when solving problems. Tanisha, age 7, said, “I can understand other kids better than the way you [the teacher] tell us how to do problems.” Shanna, age 9, said, “I get a chance to find out if they agree or disagree with me, and I get to see how they solved the problem and ask them questions about their answer.”

In the past, I did not give children the opportunity to share their solutions with one another. There was little time in our hectic schedule for such a time-consuming activity, and I thought that there really was not anything interesting to share because all the children solved the problem the same way, using a strategy I had taught them. Now I realize that young children need a chance to share their thoughts orally for the following reasons:

- Children often learn as much from one another as they do from their teacher.
- Young children often lack the skills to clearly and completely describe their solution process in writing. This is reflected in the comment of Justin, age 8: “Writing about how I got the answer is hard, but I can tell you what I did real easy.”
- For some young children, becoming a good writer in mathematics means first becoming a fluent speaker of the language.
I do not mean to suggest that teachers should not encourage children to represent their solutions in writing. I frequently remind children, “Recording your solution in writing not only helps others see how you solved the problem but also helps you do your best thinking.” This is because “representations can help students organize their thinking...[and they] help make mathematical ideas more concrete and available for reflection” (NCTM 2000, p. 68).

Young children want to become problem solvers, and their enjoyment of problem solving increases when the irregularities in their development are acknowledged by adults. Bradley, Andrea, and other children have taught me the importance of accepting the irregular nature of children’s development as problem solvers. “Sometimes I get real smart, and then I can’t remember how smart I was,” said Bradley, age 9. “I don’t know how I do it, but all of a sudden I can solve a problem I couldn’t figure out before—like it just hits me, like I’ve been zapped with a smart laser or something,” said Andrea, age 9.

I now realize that I must be very patient, because the growth of young children as problem solvers is anything but steady and continuous. One of the teachers in our school has characterized this type of development as “bump, bump, jump” learning. Beginning problem solvers often seem to “bump along,” and then one day they “jump” to a much higher level of understanding. Therefore, I have learned to be very patient when children are bumping along, but I also have learned to be prepared for children to unexpectedly jump to a new level of thinking. This enables me to maximize their

---

**FIGURE 5**

Sample responses from children in the author’s multiage first-, second-, and third-grade classroom

Which number does not belong with the others? Why?

<table>
<thead>
<tr>
<th>6</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>12</td>
</tr>
</tbody>
</table>

Annie. I think it is 6 because 6 is a little number and the rest are big numbers.

Todd. I think it is 6 because it is one digit and the others are two digits.

Breanna. I think it is 6 because if you make it turn over you get a 9, but if you turn over 10, 12, and 15, you don’t get anything.

Jose. I think it is 15 because 15 is odd and the others are even.

Stephanie. I think it is 15 because you can’t cut it in half like you can cut 6 in half and get 3, and cut 10 in half and get 5, and cut 12 in half and get 6, but you cut 15 in half and what do you got?

Taylor. I think it is 15 because 15 is not on the clock and 6, 10, 12 are on the clock.

Tanisha. I think it is 10 because when you count by threes you don’t say “10.”

Patrick. I think it is 10 because if you spell it backwards it makes a word, net. But if you spell the others backwards you won’t get a word.

Sarah. I think it is 10 because it rhymes with a lot of words like men, Ben, hen, when, pen, den, Ken, and 6, 15, 12 don’t rhyme with very many words. Well, I guess 6 does, like fix and sticks, but I still don’t think it rhymes with as many as 10.

Joel. I think it is 12 because it gets an even number of letters and the others gets an odd number of letters.

Katrina. I think it is 12 because if you go 6, 6, 6, 6, 6, you get 30, and if you go 15, 15, you get 30, and if you go 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, 3, you get 30, but 12 don’t get 30.

Tim. I think it is 12 because it is wrong; there should be 19 because then it would count 4 on the sides and 9 on the top and bottom (10 – 6 = 4; 19 – 15 = 4; 15 – 6 = 9; 19 – 10 = 9).

9

4 | 6 | 15 | 4
10 | 19 | 9
learning and help them jump as high as possible.

Children sometimes appear to be regressing when they are unable to solve problems that they previously could solve with ease (Richardson 1997). They seem to pass through a state of temporary disorientation as they reorganize their thinking into more sophisticated forms of reasoning. Perhaps the brain is going through something similar to the remodeling of a kitchen. During the remodeling process, the kitchen is not functionally usable—it is not the old kitchen it once was, nor is it the new kitchen it soon will be—but when it is finished, it is a superior version of its predecessor.

**Conclusion**

How can teachers make problem solving more enjoyable for children? Although no simple answer to this question exists, I have found that children’s enjoyment of problem solving increases when they—

- solve problems in ways that make sense to them;
- learn to appreciate mistakes as a necessary and valuable part of the problem-solving process;
- experience the satisfaction of overcoming a challenge;
- share and discuss their solutions with peers; and
- receive support and encouragement when their development slows or appears to regress.

By listening to the advice of children, I have been able to create a classroom environment in which children not only find problem solving enjoyable but also experience a culture of discourse that allows them to grow and develop as problem solvers. I have found that children are natural problem solvers who can solve problems by working alone or in groups. When given the chance to routinely share their solutions with their peers, children—

- find ways to communicate their thoughts;
- invent ways to examine and evaluate their ideas before sharing them in public;
- develop techniques to critique others’ ideas and provide useful feedback; and
- develop the capacity to compare different solutions and expand their understanding of the mathematics embedded in problems.

As *Principles and Standards for School Mathematics* describes, “The challenge at this level [K–5] is to build on children’s innate problem-solving inclinations and to preserve and encourage a disposition that values problem solving. . . . By allowing time for thinking, believing that young students can solve problems, listening carefully to their explanations, and structuring an environment that values the work that students do, teachers promote problem solving and help students make their strategies explicit” (NCTM 2000, pp. 116, 119). I will continue to rely on children as resources for clues to unlock their natural talents and abilities as problem solvers. I also will continue to seek their help in finding answers to difficult questions such as “How can I help make problem solving enjoyable for children?”

**References**


Readers who enjoy this article might find the author’s new book valuable. To order Share and Compare: A Teacher’s Story about Helping Children Become Problem Solvers in Mathematics, call (800) 235-7566 or visit www.nctm.org/catalog.—Ed.