A Focus on Making Great Problem-Solvers

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A Focus on Making Great Problem-Solvers

by

Lisa Renee Malik
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A thesis submitted to the Department of Education and Human Development of the State University of New York College at Brockport in partial fulfillment of the requirements for the degree of Master of Science in Education
A Focus on Making Great Problem-Solvers

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Abstract

The main focus of this action research was to design and implement a strategy that students could use to help them in the problem-solving process, mainly multi-step problems that are the main focus on the state assessments. Through the research of relative literature I saw that each focused on four major steps that should be used when problem-solving. These four steps are closely aligned with Polya's problem-solving process. I first made a pre-test that had three previous state exam questions. My goal here was to show that students are struggling with using problem-solving techniques to solve multi-step mathematical problems. Students struggle with reading comprehension and common mathematic vocabulary. Students can solve basic computational math problems, but when embedded within a word problem, this becomes rather cumbersome. To help aid students in this process my fellow colleagues and I devised a graphic organizer that was based off of Polya's problem solving process. We called this organizer QNPS. This graphic organizer was to help students organize their thought process into four major steps. Throughout the first semester I gave what I thought was ample time trying this process. Students were then given a test/survey similar to the pre-test. The last measurement piece would be the seventh grade state exam. Through this research process I learned that if students are to be successful on these state exams then we need to teach more than just content. We need to model how the content can be imbedded into real-life application questions.
Introduction to Action Research

President George W. Bush signed The No Child Left behind Act (NCLB) into law in 2002. It is the latest revision of the 1965 Elementary and Secondary Education Act. The overall purpose is to ensure that each child in America is able to meet the high learning standards of the state where he or she resides. One goal of NCLB that was implemented in the 2005-2006 school year is the annual testing of all students against state standards in reading and mathematics in grades 3-8 (New York State Education Department [NYSED], 2006). Through this objective schools are working towards the goal of 100 percent of students meeting the state standards by the 2013-2014 school year. Albion Middle School’s math department, where I teach, is trying to work together to create a cohesive plan to see an increase in our students meeting the state standards.

There are numerous challenges associated with the state testing, such as the timed restraint of the test, the low reading ability for numerous students, and the difficult vocabulary and multi-step process within the test questions. Since public schools must follow No Child Left Behind, the new state standards as well as the state assessment exams, classroom teachers must equip themselves with strategies that will increase student achievement and learning. The purpose of this action research is to find successful, specific strategies that math educators could utilize to help in the test taking process. In my research I must determine how I will define a “successful” strategy and consider what makes this strategy successful and how will I measure it. How can I ensure that this strategy is aligned with the new state standards?
In my classroom teachings I have noticed the importance of reading in mathematics. Through my experiences in working with the eighth grade assessment tests, I have discovered that students experience more difficulty with the comprehension of the question, than with the actual mathematics involved with each question. By being involved in the grading process for several years, I have noticed students struggling with the common mathematical vocabulary, and the intensive reading that is involved with the state assessment tests. Our entire math department strives to incorporate reading strategies into our everyday curriculum to help eliminate these issues on the upcoming state exams. Through this action research I hope to learn how the reading and text in mathematics differs from other content areas and if there are strategies specific to the math content area? Will the reading strategies implemented in ELA help or support students in mathematics class?

It is crucial that all math teachers within a school district use common strategies and terminology so as to provide consistency within the math curriculum. Students will use these strategies in other classes as well as throughout their lives as learners. As an educator, I want to avoid “teaching to the test.” How will I prepare my students for success on the state assessment, while creating life-long learners?
No Child Left Behind

The NCLB is a federal education law, where its sole purpose is to close the achievement gap through flexibility, accountability, research-based instruction, and options for parents, so that “no child is left behind (NYSED, 2006).” Under NCLB Title I schools are mandated to test students in grades 3-8 in reading and mathematics to measure student achievement and progress, which must be aligned with the State Learning Standards. The annual state testing began in the 2005-2006 school year. By 2014, all students are expected to perform at their state’s level in reading, language arts, math, and science. Districts are measured by whether or not students meet or exceed the state standards. Schools are to provide additional academic assistance for those students who do not meet the New York State standards. New York State’s definition of “all students” include students with disabilities, limited English proficiency, from low-income families and/or sub-groups of different races and ethnic groups, where there are at least 30 students in the subgroups (“Striving to Leave,” 2005-2006). The inclusion of these subgroups in our annual testing scores necessitates teachers from all curriculums to teach skills that will help increase student achievement to reach the 2014 goal.
New York State Math Assessment

The 2005-2006 is the first school year where the annual testing of ELA and mathematics began. In mathematics students are expected to apply the skills and knowledge that will be gained in the classroom in order to answer three types of questions: multiple-choice, short-response, and extended-response (NYSED, 2006). On the seventh grade math assessment students are expected to answer 30 multiple-choice questions within a 50-minute time frame without access to a calculator, four short-response questions, and four extended response questions with also a 50-minute time frame but with the use of calculators. On the short/extended response section students are expected to show their work and explain their answers. In seventh grade 30% of the test will assess Number Sense and Operations, 12% Algebra, 14% Geometry and Measurement, and 30% Probability and Statistics. (NYSED, 2006).

The eighth grade test is slightly different. Students are expected to answer 27 multiple-choice questions in 45 minutes, 12 short-response questions and 6 extended-response questions in 100 minutes. The math assessment tests assess both the content and process strands of NYS Mathematics Standard 3. In eighth grade 11% of the test will assess Number Sense and Operations, 44% Algebra, 35% Geometry, 10% Measurement, and 0% Probability and Statistics (NYSED, 2006). This break down given by the state has been very helpful in preparing our students for the upcoming exam.

The format for the seventh and eighth grade math state assessments is problematic for a variety of reasons. Students struggle with the time restraints of the multiple-choice portion of the exam. Students are expected to read, comprehend, and
solve the question without the use of a calculator leaving approximately 1.6 minutes per question. This is very difficult when these questions are testing more than one skill. Through these tests students' "conceptual understanding, procedural fluency, and problem-solving abilities are assessed rather than their knowledge of isolated skills and facts" (NYSED, 2006, p. 19). Secondly, the math assessment tests more than their mathematical ability. Many of the questions test reading skills. The increase in mathematical vocabulary and symbols, the wording and organization of the question itself and the level of difficulty poses great challenges for many middle level students, for it is seen as a reading assessment.

Math Text is Different

Many students are anxious of the math state assessment. Student disposition for mathematics, the increase use of symbols and vocabulary, and the text organization makes the assessment extremely difficult for students who are not reading at grade level and are lacking prior knowledge to answer the majority of the questions (Barton & Heidema, 2002). Given these challenges facing many middle school students it is imperative that math teachers both recognize these problems and implement strategies to help students learn and succeed.

Many middle school students are reading below the grade level expected which affects their achievement and motivation. Some students are turned off immediately by mathematic problems because of the amount of reading and decoding that is involved. Many students simply do not see the value in what they are being asked to solve.
Many students also have a difficult time with mathematic vocabulary and decoding. “Mathematics text presents more concepts per word, sentence, and paragraph than any other content-area” (Barton & Heidema, 2002, p. 14). The use of symbols and graphics compromise the question even more. When students are reading mathematical problems they must connect each symbol with an idea or an English word. This is extremely difficult for struggling readers, not reading at grade level, and where English is not the primary language. For instance, in a study of a textbook series for seventh and eighth grade mathematics, 130 symbols were found in the five most common textbooks (Barton & Heidema, 2002). To make it even more challenging, these mathematical symbols can be written several different ways. For example, twelve divided by four can be represented by using different symbols: 12 ÷ 4, 12/4, or 4√12. The same is true for vocabulary associated with multiplication. Multiply three by five, three times five, or the product of three and five. Using symbols could even add more representations: 3 x 5, 3(5), or 3 · 5. When these are then added into mathematic problems the question becomes increasingly more intense. An added challenge to the test is inclusion of diagram, graph, and table analysis. Students must be able to shift from text form to picture form within one question. The overlap between mathematics and everyday English vocabulary can be very complex. The word difference can also easily confuse a struggling reader. What is the difference between 4 and 7? The student might answer 4 is even and 7 is odd, when the actual answer was three. The words average and similar also have different meanings in the content areas. A final reason mathematic vocabulary is a
challenge is that certain concepts are embedded in other mathematical concepts (Barton & Heidema, 2002).

The text organization is not typically the same for each question. The question may appear at the beginning, middle, or the end. Extra information that is not needed to solve the question may also appear, and numbers may be in numerical form or word form. The problems in mathematics are each laid out differently. For example, one question may state, “Find the volume.” Whereas another question may ask, “How much water is needed to fill the tank?” Both questions ask students for the same answer and test for the same skill, yet depending on the vocabulary given, the question may appear more difficult to a middle level student.

We, as educators, must devise strategies that will increase motivation, student vocabulary and internalization of symbols, and a strategic plan to facilitate decoding of a question.

Benefits of the Math Assessment
The test however, and the state curriculum is trying to close this gap. They are using real-world applications that will someday have relevance in their lives. The mathematic assessment actually helps counteract this problem. Through the short/extended response questions the state rarely tells the student the method they are looking for. Many of these questions have several methods, which leaves choices for the students. Secondly, students are given partial credit for incorrect answers. The process is the important piece of this section.
Critical Thinking/Metacognition

The National Council of Teachers of Mathematics (NCTM) standards have moved towards a more constructivist, problem-solving math curriculum, directing the focus toward an increase in thinking, reasoning, and communicating mathematically. The focus of the State Math Assessment is on the comprehension of the problem rather than the process used to find the solution. For students to be successful they must be able to read, understand, interpret, analyze, synthesize, and explain their reasoning processes (Billmeyer, 2004). The assessment has taken mathematics and is really pushing Bloom’s Taxonomy with higher order thinking questions. Mathematic teachers are now enduring the task to teach students these reading skills as well as the basic skills necessary to solve problems. “Efficacious math teachers must take on the challenge of creating a toolbox of strategies to help their students become math readers and writers” (Billmeyer, 2004, p. 152). Critical thinking has become more commonplace among our mathematic classroom due to the state assessment. Students must be able to evaluate the information in the problem, determining that which is relevant to solving the problem, determine what solution the problem demands, assessing which problem-solving strategy is appropriate, applying the strategy, and then determining if the answer makes sense. In addition they may have to verbalize their thinking using mathematical vocabulary, symbols, and pictures (Billmeyer, 2004).

Metacognition is the awareness and understanding of one’s own learning process. They Monitor and have control over their learning and use appropriate strategies to assist their learning (Billmeyer, 2004). Through the state assessment this
is their objective to increase students' critical thinking skills. As educators there is no easy way to teach this, we must provide effective strategies to increase and develop these skills in the earlier grades. Since each problem on the state assessment may involve many different skills we must provide a toolbox of strategies that they can use.
What Can be Learned from Prior Research?

Through the NCTM standards they are intending to have a more constructivist, problem-solving curriculum, which includes an increase in thinking, reasoning, and communicating mathematically (Billmeyer, 2004). With the emergence of standardized assessment that expect students to read and interpret various types of problems, analyze appropriate strategies, perform the necessary math skills, and justify the reasonableness of their answer students need a heuristic approach to confront various type of problems. On extended constructed –response tasks, which require students to solve problems requiring greater depth of understanding and then explain at some length their solution, the average student producing satisfactory or better response was 16 percent at grade 4, 8 percent at grade 8, and 9 percent at grade 12 (Lester, 1994). This statement shows a desperate need for increased knowledge and study of problem solving skills.

Hunter Ballew and James W. Cunningham of the University of North Carolina conducted research to understand the connection between reading and computational skills. They wanted to find out what was more difficult for students – is it reading the problem or computational skills? Where are students lacking skills? Ballew and Cunningham assert that for students to demonstrate mastery of the process, they must possess four abilities: read the problem, set up the problem, perform the necessary skill or computation, and integrate reading, interpreting and computation (Ballew & Cunningham, 1982). To gather data they used a basal mathematics test for grades 3 through 8. Students were given three problems. The first was pure computation, the second was a test of interpretation, and the third was a reading/problem interpretation.
As a result of their research they concluded that having one ability is not enough. Students must have all four of the components and they found that many students do not. "Twenty six percent of the students tested, could not work word problems at a level as high as that at which they could compute, interpret, and read and interpret when these areas were measured separately" (Ballew & Cunningham, 1982, p. 209). When they were asked to perform a multi-task step they did not show mastery. When tested solely on computations, they exhibited mastery. When tested solely on interpretation, students exhibited mastery and so on and so forth. Students need to learn mastery of the multi-step process. They also concluded that students lacked reading comprehension skills and this directly affected their performance on the math question at hand. "For instance, 60 percent of the subjects tested could compute correctly at a higher level than they could read and set up the problem" (Ballew & Cunningham, 1982, p.209). Clearly, as educators we must begin to focus on reading in the content area.

Randall I. Charles and Frank K. Lester, Jr. conducted a similar study that involved a Mathematical Problem Solving Program that was implemented for twenty-three weeks. This study had ten seventh grade teachers teach the experimental group and thirteen seventh grade teachers teach the control group. Through this study there were three questions raised. First, they wanted to compare the problem solving performance to that of students whose only exposure to problem solving was through regular classroom text books. Secondly, they wanted to examine the nature of the changes in students’ problem solving performance. Thirdly, they wanted to look at
teachers' attitudes towards teaching mathematical problem solving (Charles & Lester, 1984). The MPS program included four characteristics: focused on Polya's four-phased model of problem solving, emphasized extensive experience with process problems, emphasized the development of students' abilities and use a variety of strategies, and lastly incorporated a specific teaching strategy for problem solving. The MPS program gave one problem solving experience for each day of the week. Three types of problems were used on the pretest, and posttests. The first was simple translation, which would only be a one-step math problem. The second was complex translation problems, which could also be thought of as a multi-step problem. Lastly, process problems which emphasized the thinking process through providing practice in understanding, developing and carrying out a plan, and evaluating solutions. The students were given a pretest, posttest, and were tested after the eighth and sixteenth weeks. Each test included four questions that were composed of two complex and two process problems. The results are as follows: Three measures of problem solving which included understanding, planning, and result were measured on the pretest and posttest. The tests included both complex translation and process problems. The control group out performed the experimental group on every pretest measure. The results were reversed on the posttest measures. For instance, in the issue of understanding the experimental group scored a mean of 2.21, whereas the control group scoured a mean of 1.81. The maximum score for each measure was 4. Similar results occurred in the measure of planning. The experimental group scored a mean of 2.16 and the control group, 1.80 (Charles & Lester, 1984). In all fields,
students in the experimental group scored on average, higher than those students in the control group. Did this program prove beneficial to students’ problem solving performance? Most definitely yes! The only question remaining is when did this success begin during the twenty three week study? The results did show that in the measure of understanding the greatest growth occurred in the first eight weeks. Within the translation problems improvement slowed in comparison with the process problems which slowed and then increased. In the measure of planning, complex problems showed the greatest improvement. In the measure of result, complex problems showed the same difference below performance. Process problems showed that the result abilities to obtain correct responses grew much less than their abilities to comprehend and devise a plan. Teachers’ attitudes and confidence proved to be more positive toward the importance of problem solving and the ability to teach it. Teachers liked that this program had structured guidelines and activities. Not only did they observe their students gain self confidence in problem solving, but also saw them learn “how to think”.

The article “A Comparison of Activity Structures During Basic Skills and Problem-Solving Instruction in Seventh Grade Mathematics,” written by Robert B. Burns and Andrea A. Lash, discussed a study that involved nine seventh grade teachers. They were observed for five consecutive days on their basic skills instruction and then observed on a six day unit surrounding four problem-solving skills. All four skills involved the analysis phase of problem solving which included: Identify important information necessary to solve the problem, separate relevant from
irrelevant numerical information, identify the steps involved, and represent the
information in a problem statement through a table or diagram (Burns & Lash, 1986).

Time Spent in Different Segment Purposes
Through the data there seemed to have a consistent pattern of time use that
was unaffected by a shift from regular instruction to problem-solving instruction. In
the development of the lesson the average number of minutes for the regular
instruction was 23 compared with 47 minutes for the problem-solving instruction.
The amount of time spent on practice on average for regular instruction was 87
minutes and 100 minutes for problem-solving instruction. The review segment for
the regular instruction averaged 37 minutes, while the problem-solving instruction
averaged 65 minutes (Burns & Lash, 1986). When this data is converted to
percentages the change seems relatively small. On average, there was a 7-
percentage-point increase during problem-solving instruction in time spent in
development and review segments, and a 4-percentage-point decrease in practice
segments.

Number of Segments, Assignments, and Problems
The average number of segments per lesson increased for the problem-solving
instruction. The average number of segments per lesson ranged from 2.25 to 4 for
regular instruction and ranged from 2.3 to 5.7 for the problem-solving instruction
(Burns & Lash, 1986). In comparison to the number of problems that were given to
both groups the regular instruction group was able to solve more than the problem-
solving group. In some cases the amount doubled. The amount is attributed to the fact that word problems are more time consuming than basic computation problems.

**Comparisons in Teacher and Observer Lesson Ratings**

Nine areas were observed using a 5-point scale, where the higher values indicate a more favorable response. In the areas of divergent orientation, use of discovery techniques, lesson challenge, and use of realistic examples showed greater difference between regular and problem-solving instruction. In the areas of teacher orientation to learning, lesson complexity, activity flow and pace, lesson closure, and classroom discipline techniques, the difference was marginal between regular and problem-solving instruction (Burns & Lash, 1986). Teachers rated their students as having more difficulty learning when it came to the problem-solving instruction compared to regular instruction. Students also seemed to be less involved in assignments and less cooperative in lesson activities during problem-solving instruction. Teachers also felt that their lessons went less as planned. Through the findings found within this study, teachers need to increase student problem solving with in the classroom. Teachers need to make problem solving an integral part of their mathematics curriculum from the early grades on up. If this is concentrated across the grade levels over time students will have the confidence and skills necessary to be successful with mathematical problem solving.

Teachers in this study organized their instruction in much the same way for both types of instruction. One teacher stated, “I had approached the same for both of them. It’s just different type of problems” (Burns & Lash, 1986, p. 410). Throughout
all three studies the main focus has been the differences between regular and problem-solving instruction. I have found that each study introduces a four step approach that could be traced back to George Polya. His major contribution to mathematics is his work in problem-solving. In 1945 he published the book How to Solve It where he identifies four basic principles or heuristics: understand the problem, devise a plan, carry out the plan, and look back (Polya, 1957). Polya states that students are often stymied in their efforts to solve problems simply because they don’t understand it fully (Polya, 1957). In this stage students must be able to identify the unknown, data, and the condition. Can students restate the problem in their own words, can they think of a picture or a diagram that might help them understand the problem, and is there enough information to find a solution? In the second stage of this process, there may be many ways to solve problems. Here is where the skill involved relies on choosing an appropriate strategy such as: guess and check, look for a pattern, draw a picture, solve a simpler problem, work backwards, etc. The third step is usually easier than devising a plan. In this phase students must bring together all their prior knowledge of necessary skills to carry out the plan. In the last step of looking back students must examine their solution, check their result, and maybe use this answer for some other problem (Polya, 1957).

Due to the increased concern over the state assessment in mathematics, we as a department wanted to implement a strategy that could break down the process of solving multi-step mathematical problems. Students’ comprehension of word problems can be enhanced by teaching them to read word problems as meaningful
passages—as short stories from which students can construct meaning based on their prior knowledge and experience (Billmeyer, 2004). We decided to use Polya’s four step process to create a graphic organizer to help students organize their reasoning in a thought out process. Since students were using the Frayer Model to help students develop their understanding of concepts, we decided to recreate Polya’s process to have the similar format. We also wanted our graphic organizer student friendly so we called the strategy Q-N-P-S. Question, Need, Plan, and Solve.
Development of Hypotheses and Outcome Measures
At the outset of my research I hypothesized that a new strategy based on Polyas’ problem solving process would help students organize their thought process and foster their problem skills that are involved in solving multi-step mathematical problems which are found on the NYS Mathematics Assessment. As a cohesive math department, which includes grades 6-8, we wanted to create a common strategy that would be developed to increase student success on the mathematics assessment. In our district we have taken on reading in the content training. In this training we are given strategies to help students develop their vocabulary and reading strategies. To increase content organization the use of graphic organizers is an excellent strategy. We decided to create a graphic organizer that would include Polya’s problem solving process. An example of the graphic organizer used is represented in Figure 1 on page 39. In this organizer students first must restate the question in their own words, secondly, they need to decide what information is needed to solve the problem, thirdly, students must devise a plan, lastly, students must solve the problem and decide if their answer makes sense. We decided to call this strategy Q-N-P-S, which is an acrostic for question, need, plan, and solve.

To measure the success or failure of the use of this strategy, each grade level decided to give their students a pre-test that included three multi-step questions from previous state exams. Our goal in giving a pretest was to have a baseline in regards to their problem solving process. Students at this present time had not been introduced to our problem solving graphic organizer. Question number one was taken from the New York Testing Program, Mathematics Book 1, May 6-7, 2003.
Andy bought a carton of milk that costs $3.10, a package of sugar which costs $1.39, and a carton of eggs that cost $2.10. How much change did he receive from $20.00?

In regards to the new Grade 7 Standards, this question fits under the process strand of Connection. Students are able to recognize the presence of mathematics in their daily lives. Question number two was created by my colleague, the other seventh grade math teacher.

Becky is buying a new car at a cost of $23,685. She will pay for it over a 60-month period. How much less will Becky pay per month if she makes a down payment of $3,000 first?

Through the use of this question, she wanted to see students’ expertise with solving problems using percents. This question also fits under the connection strand. Question number three was taken from the New York Testing Program, Mathematics Book 2, May 15 and 16, 2001.

Alicia is making a pattern with equilateral triangles. She started with one equilateral triangle and is adding equilateral triangles to the perimeter of each design. The first four designs in her pattern are shown below.
If Alicia continues the pattern shown above, how many equilateral triangles will she add to Design 5 to get Design 6?

This question involves the Problem Solving Strand, where students may observe a pattern to solve this problem. There could be several methods in solving this problem. The grading of each of these questions was based on a two point holistic rubric taken from the New York Testing Program in Mathematics. In Figure 2 on page 40, an example of this rubric is represented.

In the next segment of my problem solving process, I decided to create a worksheet that involved three questions from the New York State Testing Program Mathematics, May 2000. At this point I introduced the QNPS graphic organizer to help students organize their thoughts. Question number one, was excellent because students had to read and interpret a table of information.

The local sports complex charges different prices for their tickets to different sporting events. The table below shows their current prices. (Anyone under 16 years of age would purchase a child’s ticket.)

<table>
<thead>
<tr>
<th>Sport</th>
<th>Child</th>
<th>Adult</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hockey</td>
<td>$4.50</td>
<td>$7.00</td>
</tr>
<tr>
<td>Basketball</td>
<td>$5.00</td>
<td>$9.00</td>
</tr>
<tr>
<td>Football</td>
<td>$6.25</td>
<td>$11.50</td>
</tr>
</tbody>
</table>

Ken’s Scout Troop earned money in order to go to Saturday’s football game. His father bought 8 tickets for the scouts and one ticket for himself, as a Scoutmaster.

When Ken’s father pays for the tickets, how much change will he receive from a $100 bill?

Students also had to decide what information was necessary and what information was extra. Question number two and three went along with our unit of study at the
time which according to the State 7 Standards would be seen though the Number Sense and Operations Strand.

Jen says, “I’m thinking of two mystery numbers. The product of the two numbers is 64. The sum of the two numbers is 20.” Can you guess the mystery numbers?

On the line below, list all the whole numbers from 1 to 100 than can be evenly divided by both 6 and 15.

Whole numbers

Describe at least one pattern that you notice in the above set of whole numbers.

How many whole numbers between 390 and 410 can be evenly divided by both 6 and 15?

Specifically can students find the common factors and greatest common factor of two or more numbers, and can students determine multiples and least common multiple of two or more numbers.

My next step in providing practice for my students in using the QNPS graphic organizer was to assign homework using this process. Question number one was taken from the New York State Testing Program Test Sampler Draft, 1998.

Each day, approximately 60 million plastic bottles are thrown away in the United States. On average, how many plastic bottles are thrown away in the United States per hour?

In regards to the new state standards, question number one would lie in the Process strand under mathematical connection. Students must recognize and apply mathematics to other disciplines, areas of interest, and societal issues. I found question number two in the New York State Testing Program, Mathematics Book 1, May 4-5, 2004.
Clara’s class is going on a trip to the local science museum. Twenty-five students, one teacher, and three parents are going on the trip. The museum charges $3.50 admission for each student and $5.00 for each adult. How much will it cost for all the students and the adults to enter the museum?

This question fits under the process strands in problem solving. These questions gave students a chance to use the QNPS strategy. I thought the questions were straightforward in practicing this process. Students should be able to pull out the information needed to solve these problems.

In my next stage of practice, students were given the QNPS graphic organizer on several homework assignments and quizzes. The questions used did not necessarily test any particular skill. I picked questions from previous state exams that would be beneficial in this process development. Each of these questions addressed the Process Strands rather than the Content Strands of the State Standards. The following questions expected students to observe and continue the pattern to answer these questions.

Question 1: Taylor’s Music Store will accept used compact disks (CDs) in exchange for the new ones. Look at the exchange table below.

**COMPACT DISK EXCHANGE**

<table>
<thead>
<tr>
<th>New CDs for Used CDs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td>4</td>
</tr>
<tr>
<td>5</td>
</tr>
<tr>
<td>6</td>
</tr>
</tbody>
</table>

If the pattern continues and Maury has 22 used CDs to exchange, what is the greatest number of new CDs he can get?

Question 2: A factory makes bicycles. The table below shows that it produced 21 bicycles during the first 4 days of production.
<table>
<thead>
<tr>
<th>Day</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Built</td>
<td>6</td>
<td>11</td>
<td>16</td>
<td>21</td>
</tr>
</tbody>
</table>

Use the table to determine how many bicycles will be built in 12 workdays if the rate remains the same.

Finding a pattern is a problem solving strategy that could be used. Students were expected to use the communication strand in the question shown below.

Juanita solved an equation incorrectly, as shown below. Explain the mistake that was made.

\[
3x + 6 = 24
\]

\[
\frac{3x + 6}{3} = \frac{24}{3}
\]

\[
x + 6 = 8
\]

\[
x = 2
\]

Students are to use appropriate mathematical language when describing mathematical solutions and rationale. Students had to use estimation from the Number Sense and Operation Strand of the Math 7 Curriculum to help students answer this question:

Jim bought 11.12 gallons of gas that cost $1.89 per gallon. What is a reasonable estimate of how much Jim paid for gas?

I found that students would not estimate at all on this question. If the state asks the student to estimate their answer within the question, then students need to exemplify that they understand this concept. In the following questions the Connection Strand was exemplified.

**Question 1:** The Refreshing Soda Company has factories worldwide. The factories produce a total of approximately 12 million cans of soda an hour. At that rate, about how many cans do the factories produce per minute?
Question 2: On Friday, Best Buy sold 34 X-Box 360 games. They sold the same number of systems on Saturday as they did on Sunday. The total number of systems sold for the three days was 118. How many X-Box 360 systems were sold on Saturday?

Students should be able to apply mathematics to areas of interest and societal issues.

In the middle of my study I created a two question test that was to measure student progress with the use of QNPS problem solving process. At the end students had to express their in opinion of this strategy. Question number one was taken from the New York State Testing Program, Mathematics Book 2, Sample Test 2005. This question is taken from the Statistics and Probability Strand of the Mathematics Grade 7 Curriculum.

Dylan has a bag containing 15 marbles. The table below shows the number of marbles of each color in the bag. As part of a probability experiment for his science class, Dylan randomly picks a marble from the bag and replaces it. He repeats this 300 times.

<table>
<thead>
<tr>
<th>Dylan's bag of Marbles</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Marble Color</td>
<td># of Marbles</td>
</tr>
<tr>
<td>White</td>
<td>3</td>
</tr>
<tr>
<td>Red</td>
<td>8</td>
</tr>
<tr>
<td>Blue</td>
<td>3</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
</tr>
</tbody>
</table>

Dylan randomly picks a marble from the bag. What is the probability the marble will be red? ____________

Predict the number of times out of 300 Dylan will pick a red marble. ____________

I graded this question using a three point holistic rubric found on page 41, figure 2. Through the use of the second question the problem solving strand was assessed. Students needed to formulate a pattern to help solve this problem. I assessed this question using the two point holistic rubric.
I concluded my research by examining the results on the Math 7 State Assessment that was given in March of 2006.
Methods and Procedures
My research on the effectiveness of one problem solving strategy was primarily quantitative. Our current educational system measures student success via grades and test scores, quantitative means. Any good teacher also measures the success and effectiveness of a strategy through observation and reflections. My research also incorporates these qualitative methods. To measure my students' success in using this problem solving strategy, I gave a pretest so I would have a baseline to measure future results. I graded each of the three questions using a two point holistic rubric used by the New York State Testing Program. I then broke down each question and totaled how many students scored 0, 1, and 2 points according to this rubric. To understand student problems, I asked students to explain any problem(s) they encountered in solving these problems. Students were then introduced to the strategy through three in-class practice problems. Throughout the first semester of school students were then given opportunity to use this strategy on a variety of previous state exam questions. To recognize student success I then gave another test that involved two state exam questions that I expected students to use the QNPS graphic organizer. At the end of this test, students were presented a survey that asked what they thought on this process. The last result measured was the Seventh Grade State Exam given in March. Although the state has not presented schools with the break down of the scores, as a department we decided to break them down into percents to measure student success. I also had the opportunity to be involved in the grading process and was given a chance to look over their
short/extended response questions to see if the strategy was a success and how students took on this part of the exam.
Analysis of Data and Interpretation of Results

The implementation of the seventh grade pre-test posed interesting results that made me conclude that students have difficulty with problem solving. For instance, question number one, a computation problem, involved two simple operations of adding and subtracting. Out of a sample of 101 seventh grade students with varying ability levels, five students had a completely incorrect response, twenty-three students had a partially correct response, and seventy-three students had a complete and correct response. In regards to the next two questions the results changed significantly. Students definitely struggled when it came to more advanced problem solving questions. Questions that involved applications with percents and building upon a pattern seem to decrease the results. Question number two produced the following results: fifty-seven students had completely incorrect responses, twenty-nine students had a partially correct response, and fifteen students had a complete and correct response. Question three produced similar results: fifty-six students had a completely incorrect response, twenty-three students had a partially correct response, and twenty-one students had complete and correct responses. Refer to Appendix A for samples of student work. After taking the pre-test I could tell students felt frustrated and concerned that I was taking this for a grade. At this point, I asked the students to write what question(s) they struggled with and why. Here are some of the common responses:

"I had a problem with #3 and a little with #2. I had trouble with #3 because of the word equilateral and #2 because of the word down payment."

"I had an issue with #2. I didn't understand how to do it. The problem wasn't stated clearly enough for me to understand."
"I had a problem with #3. The pattern confused me because it was going in an order I didn’t know."

"#3 didn’t understand the question."

"Number 3 was a little confusing at first. I didn’t understand the question and what they were asking, but then I read it again and looked at the shapes and then it got easier."

When reading through these responses students struggled with questions two and three just like my results show. Students had a difficult time with questions two and three which involved more than computation. For a more detailed representation of my data please refer to Graph 1 on page 34.

My next quantitative results taken from the QNPS Test/Survey involved two questions that were involved just like questions two and three from the pre-test. Question number one that tests students’ probability ability and question two that tests students’ ability to build upon a pattern just like question number three from the pre-test produced the following results. This test was taken from a sample of 104 students instead of 101 students due to students moving into the district. According to the three point holistic rubric eighteen students had completely incorrect responses, fifty-five students had incomplete response and exhibits many flaws but is not completely incorrect responses, eleven students had partially correct responses and twenty students had complete and correct responses in regards to the probability question. I was hoping for better results on this question. Students lost the majority of their points in regards to the second part of this question: “Predict the number of times out of 300 Dylan will pick a red marble.” In respect to this question, I feel that was in-part my fault. I never went into detail on how to solve this particular problem.
when it came to my probability unit. On question number two, regarding patterns, twenty-eight students had completely incorrect responses, twenty students had partially correct responses, and fifty-six students had complete and correct responses. See Appendix A for student work. When looking back at the pre-test, on patterns I felt my students improved. For a more precise account of the findings, please refer to Graph 2 on page 35. This improvement could be attributed to the amount of pattern questions I introduced throughout the semester. At the end of this test students were expected to answer this question.

On several occasions since September, we have used QNPS to help in the multi-step problem solving process. In the following space, I would like you to express your opinion of the strategy. Do you like or dislike the strategy? Why or why not?

The sole purpose of this question was to see how the students felt about the process I had introduced and if they thought it was beneficial or worthy of their time. Here are some of the students’ responses:

“Yes, because it helps sort each thing out so that you don’t have to keep looking back at the questions all the time for the answers. All you have to do is look at one of the boxes and it gives you the information that you need to answer the problem.”

“I think the strategy helps a little more than just reading a word problem and trying to solve it makes us plan out more information we need. So in my opinion we should keep the QNPS strategy.”

“I like this strategy. It makes things much easier and it keeps things organized. On some occasions people can work out a problem better if they take it one step at a time.”

“No, I don’t like the strategy QNPS. I think it takes to long and all the steps are not necessary to solve the problem. I think it makes the problem harder to understand because it breaks it down to much so there are to many parts to the problem.”
"I do not like this strategy mainly because it eats up to much time when we are trying to finish our tests. Also, it makes you think about the things besides the answer that is why I don't like the QNPS."

"I dislike this strategy because it takes to long and I could get the same answer a shorter way."

By reading through student responses I felt it was equally liked and disliked. The students' primary concern was that they felt this process was tedious and they could get the right answer without this strategy. My main goal of implementing this strategy was to give students a way to organize their thoughts. Their belief that the strategy would automatically lead them to the correct response was a huge misconception. Students misunderstood the purpose of the QNPS strategy and thus, did not fully recognize its value in problem-solving.

My last quantitative measure that I chose was the Seventh Grade State Assessment. Measuring students' results was rather difficult, because I did not have the opportunity to grade only my students' tests and I only graded certain questions that were assigned. The other difficulty in this measurement process was that the individual student scores have not come back from the state. Since, Albion Central School needed some results for the implementation of Academic Intervention Services (AIS) the school transposed the scores into percents. Then the Math Department broke the scores down into four performance levels. If students scored in the areas of a three and four, students are meeting state standards. If students scored in the areas of one and two, students are not meeting state standards. Our goal is to have the majority of our students in the level three and four performance level. If students scored between an 80%-100% students provided evidence of superior
knowledge of key mathematical ideas they would fall into level four. Students fell into level three if the range was 60%-79%. In this level, students show consistent knowledge of key mathematical ideas. If students fell between 40%-59% they were classified as a level 2. Students in this area show a basic reasoning of key mathematical ideas. Lastly, students were classified as level one if they scored 0-39%. If students are in this level students may understand key mathematical ideas, but do not provide evidence of mastery. We understand that our results could and probably will change when the scores are sent back. The scoring process was just to give us a baseline of our results that could be used for the upcoming school year.

There were 114 students who took the state assessment: 17% fell into level four, 41% fell into level three, 34% fell into level two, and 8% fell into level one. Since, this was the first time giving this test and implementing the new curriculum we have no prior baseline to go from. Through my participation in the grading process, I did not see any of my students use the QNPS strategy on the short/extended response questions. This observation disappointed me to some degree. I am assuming that by using this strategy throughout the first semester of school, students learned to slow down and justify what information was necessary to solve the problem. This strategy doesn't solely have to be implemented on paper, but students can reason through this strategy in their head.
Graph 1: Results of Pre-Test Question Number 1
Computation

Graph 1: Results of Pre-Test Question Number 2
Percent Application
Graph 1: Results of Pre-Test Question Number 3
Pattern

Graph 2: Results of Test/Survey Question Number 1
Probability
Graph 2: Results of Test/Survey Question Number 2
Pattern
Reflection

This action research project has taught me a lot about my teaching practices. I have seen the importance districts hold on state assessment first hand. I have been involved in the grading process of mathematics assessment for several years and work cohesively with our math department. Through our summer curriculum planning we have pinpointed a problem with student success on these particular assessments. I picked this particular project to help me find strategies to help my students succeed. Since our district was already implementing the Reading in the Content program, what better way to be involved? As a department we saw a problem and devised a plan to help alleviate the student struggle with short/extended response questions. The strategy was from the onset called QPNS, but through working with this graphic organizer I noticed that students could not plan without sorting what information is needed to solve the problem. I decided to keep the same organizer but rather change the order to QNPS.

Through the process of this action research I had a really difficult time having students buy into this process of problem solving. Two barriers that prevented some students with accepting this process were the limited amount of teacher materials and the newness of the seventh grade state exam and curriculum. I tried to introduce and use this graphic organizer where ever I saw the need and opportunity. By mid semester many of my colleagues essentially stopped using the QNPS because they thought it proved too confusing and did not wish to put in the time and effort. We were hoping that the QNPS strategy would be taught by myself first, and then
continued and further developed through the rest of middle school. I felt as though I
was teaching this in a vacuum.

By working with multi-step problems students struggle with mathematical
vocabulary and this process does not counteract this problem. Problem solving is a
life long process and is developed throughout their mathematical career. Many
teachers teach the curriculum and expect students to know how to approach and solve
these multi-step problems, when in fact students are not used to math problems being
this involved with length, reading, and vocabulary. Teachers need a new approach to
help students succeed in this portion of the assessment. I wanted to give students an
opportunity to think of these problems in an organized fashion. I think if students are
introduced to this organizer from the earlier grades this would have been better
perceived. To introduce this at the beginning of seventh grade I think made it more
difficult to have students buy into. I think problem solving should be part of the math
curriculum just like solving equations is part of the curriculum.

Next year, we are getting rid of study halls and are able to teach an extra math
class to all our students. I have decided to continue this process in that extra class. I
will introduce this organizer from day one and concentrate on problem solving
activities and shot/extended response questions throughout this class. I believe that
on next year’s state assessment I will see student work using QNPS. My goal is to
implement and refer to it on a daily basis rather than intermittently. I have also
thought about showing how this strategy will work in other content areas other than
math. Hopefully, students will then feel ownership to this process.
Figure 1: Mathematics QNPS Graphic Organizer

<table>
<thead>
<tr>
<th>Question?</th>
<th>Need</th>
</tr>
</thead>
<tbody>
<tr>
<td>(What is the question?)</td>
<td>(Information needed to solve)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plan</th>
<th>Solve</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Strategies)</td>
<td>(Show your work)</td>
</tr>
</tbody>
</table>

Explain why your answer makes sense.
**Figure 2: Holistic Rubrics**

*2-Point Holistic Rubric for Math 7 Problem Solving Pre-Test*

<table>
<thead>
<tr>
<th>Points</th>
<th>Description</th>
</tr>
</thead>
</table>
| **2 Points** | A two-point response is complete and correct.  
This response  
- demonstrates a thorough understanding of the mathematical concepts and/or procedures embodied in the task  
- indicates that the student has completed the task correctly, using mathematically sound procedures  
- contains clear, complete explanations and/or adequate work when required |
| **1 Point** | A one-point response is only partially correct.  
This response  
- indicates that the student has demonstrated only a partial understanding of the mathematical concepts and/or procedures embodied in the task  
- addresses some elements of the task correctly but may be incomplete or contain some procedural or conceptual flaws  
- may contain an incorrect solution but applies a mathematically appropriate process  
- may contain a correct numerical answer but required work is not provided |
| **0 Points** | A zero-point response is completely incorrect, irrelevant, or incoherent, or a correct response arrived at using an obviously incorrect procedure. |
**Figure 2: Holistic Rubrics**

### 3-Point Holistic Rubric

<table>
<thead>
<tr>
<th>Points</th>
<th>Description</th>
</tr>
</thead>
</table>
| **3 Points** | A three-point response is complete and correct.  
This response  
• demonstrates a thorough understanding of the mathematical concepts and/or procedures embodied in the task  
• indicates that the student has completed the task correctly, using mathematically sound procedures  
• contains clear, complete explanations and/or adequate work when required |
| **2 Points** | A two-point response is partially correct.  
This response  
• demonstrates partial understanding of the mathematical concepts and/or procedures embodied in the task  
• addresses most aspects of the task, using mathematically sound procedures  
• may contain an incorrect solution but applies a mathematically appropriate process with valid reasoning and/or explanation  
• may contain a correct solution but provides incomplete procedures, reasoning, and/or explanations  
• may reflect some misunderstanding of the underlying mathematical concepts and/or procedures |
| **1 Point** | A one-point response is incomplete and exhibits many flaws but is not completely incorrect.  
This response  
• demonstrates only a limited understanding of the mathematical concepts and/or procedures embodied in the task  
• may address some elements of the task correctly but reaches an inadequate solution and/or provides reasoning that is faulty or incomplete  
• exhibits multiple flaws related to a misunderstanding of important aspects of the task, misuse of mathematical procedures, or faulty mathematical reasoning  
• reflects a lack of essential understanding of the underlying mathematical concepts  
• may contain a correct numerical answer but required work is not provided |
| **0 Points** | A zero-point response is completely incorrect, irrelevant or incoherent, or a correct response that was arrived at using a obviously incorrect procedure. |
1. Andy bought a carton of milk that costs $3.10, a package of sugar which costs $1.39, and a carton of eggs that cost $2.10. How much change did he receive from $20.00?

*Show your work.*

\[ \begin{array}{c}
3.10 \\
+ 1.39 \\
2.10 \\
\hline \\
6.59
\end{array} \]

\[ 20.00 - 6.59 = 13.41 \]

\[ 13.41 + 1 = 14.41 \]

**Answer:** $14.41

2. Becky is buying a new car at a cost of $23,685. She will pay for it over a 60-month period. How much less will Becky pay per month if she makes a down payment of $3,000 first?

*Show your work.*

\[ \frac{23,685 - 3,000}{60} = 344.75 \text{ a month} \]

\[ 394.75 - 344.75 = 50.00 \]

**Answer:** $50.00
3. Alicia is making a pattern with equilateral triangles. She started with one equilateral triangle and is adding equilateral triangles to the perimeter of each design. The first four designs in her pattern are shown below.

If Alicia continues the pattern shown above, how many equilateral triangles will she add to Design 5 to get Design 6?

**Show your work.**

Every time she adds them, she multiplies the design number before it by 3.

Example: $1 \times 3 = 3$ so from Design 1 she has to add 3 and so on.

Answer: 15 triangles
1. Andy bought a carton of milk that costs $3.10, a package of sugar which costs $1.39, and a carton of eggs that cost $2.10. How much change did he receive from $20.00?

*Show your work.*

\[
\begin{align*}
3.10 & \quad 2.10 \\
+1.39 & \quad +0.59 \\
\hline
6.59 & \\
-20.00 & \\
\hline
13.41 & \\
\end{align*}
\]

*Answer* $\$ \underline{13.41}$

2. Becky is buying a new car at a cost of $23,685. She will pay for it over a 60-month period. How much less will Becky pay per month if she makes a down payment of $3,000 first?

*Show your work.*

\[
\begin{align*}
23,685 & \quad 3,000 \\
-20,685 & \quad \underline{314.65} \\
\hline
& \quad \underline{20,685} \\
\end{align*}
\]

*Answer* $\$ \underline{344.75}$
3. Alicia is making a pattern with equilateral triangles. She started with one equilateral triangle and is adding equilateral triangles to the perimeter of each design. The first four designs in her pattern are shown below.

Design 1  Design 2  Design 3  Design 4

If Alicia continues the pattern shown above, how many equilateral triangles will she add to Design 5 to get Design 6?

Show your work.

Answer: 15 + 9 + 6 = 30

I had a problem with p's with 2 + 3 because I couldn't get the process of solving it.
1. Andy bought a carton of milk that costs $3.10, a package of sugar which costs $1.39, and a carton of eggs that cost $2.10. How much change did he receive from $20.00?

*Show your work.*

\[
\begin{array}{c}
3.10 \\
+ 1.39 \\
+ 2.10 \\
\hline
6.59 \\
\end{array}
\]

\[
\begin{array}{c}
19.00 \\
- 6.59 \\
\hline
13.41 \\
\end{array}
\]

*Answer* \$13.41

2. Becky is buying a new car at a cost of $23,685. She will pay for it over a 60-month period. How much less will Becky pay per month if she makes a down payment of $3,000 first?

*Show your work.*

\[
\begin{array}{c}
23,685 \\
- 3,000 \\
\hline
20,685 \\
\end{array}
\]

\[
20,685 \div 60 = 344.75
\]

*Answer* \$344.75
3. Alicia is making a pattern with equilateral triangles. She started with one equilateral triangle and is adding equilateral triangles to the perimeter of each design. The first four designs in her pattern are shown below.

Design 1  Design 2  Design 3  Design 4

If Alicia continues the pattern shown above, how many equilateral triangles will she add to Design 5 to get Design 6?

Show your work.

\[
\begin{array}{c}
1 \quad 2 \\
\quad + \quad 3 \\
\quad \frac{1}{5}
\end{array}
\]

\[+2\]

Answer 15

Number 3, the process
Dylan randomly picks a marble from the bag. As part of a probability experiment for his science class, Dylan randomly picks a marble from the bag and then replaces it. He repeats this 300 times.

### Dylan's Bag of Marbles

<table>
<thead>
<tr>
<th>Marble Color</th>
<th># of Marbles</th>
<th>300 picks</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>3</td>
<td>60 times</td>
</tr>
<tr>
<td>Red</td>
<td>8</td>
<td>160 times</td>
</tr>
<tr>
<td>Blue</td>
<td>3</td>
<td>60 times</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
<td>20 times</td>
</tr>
</tbody>
</table>

Dylan randomly picks a marble from the bag. What is the probability the marble will be red? \( \frac{8}{15} \)

Predict the number of times out of 300 Dylan will pick a red marble. 160

**Question? (What is the question?)**

What's the probability of getting a red?

**Plan (Strategies)**

1) Fraction of how many reds he'll pick
2) See how many times 15 goes into 300
3) \( \frac{8}{15} \times \frac{15}{15} = \frac{8}{15} \)

**Need (Information needed to solve)**

15 marbles
8 red marbles
Picks 300 times

**Solve (Show your work)**

\[ \frac{8}{15} \times \frac{15}{15} = \frac{8}{15} \times \frac{15}{100} = \frac{120}{1500} = \frac{160}{200} = \frac{8}{10} = \frac{4}{5} \]
How many dots will be in the 7th figure if the pattern continues?

<table>
<thead>
<tr>
<th>Question?</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>(What is the question?)</td>
<td>(Strategies)</td>
</tr>
<tr>
<td>How many o's will be in #7's figure?</td>
<td>1) add 5 to 4th figure</td>
</tr>
<tr>
<td></td>
<td>2) add 6 to 5th &quot; &quot;</td>
</tr>
<tr>
<td></td>
<td>3) add 7 to 6th &quot; &quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Need</th>
<th>Solve</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Information needed to solve)</td>
<td>(Show your work)</td>
</tr>
</tbody>
</table>
| add another row each time whatever number it is that's how many you add | \[
\begin{array}{c}
10 \\
+5 \\
\hline
15 \\
+6 \\
\hline
21 \\
+7 \\
\hline
28
\end{array}
\]|

On several occasions since September, we have used QPNS to help in the multi-step problem solving process. In the following space, I would like you to express your opinion of the strategy. Do you like or dislike the strategy? Why or why not?

I like this strategy. I like it because all your doing is adding another diagonal row to it. For example, figure 1 added a diagonal row, 2 added another diagonal row and so on. I like this strategy. If you get how to do it you'll be fine. It might be harder if you don't.
Dylan randomly picks a marble from the bag. As part of a probability experiment for his science class, Dylan randomly picks a marble from the bag and then replaces it. He repeats this 300 times.

<table>
<thead>
<tr>
<th>Marble Color</th>
<th># of Marbles</th>
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<tbody>
<tr>
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<td>3</td>
</tr>
<tr>
<td>Red</td>
<td>8</td>
</tr>
<tr>
<td>Blue</td>
<td>3</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
</tr>
</tbody>
</table>

Dylan randomly picks a marble from the bag. What is the probability the marble will be red? \(\frac{8}{15}\)

Predict the number of times out of 300 Dylan will pick a red marble. \(160\)
How many dots will be in the 7th figure if the pattern continues? 

<table>
<thead>
<tr>
<th>Question? (What is the question?)</th>
<th>Plan (Strategies)</th>
</tr>
</thead>
<tbody>
<tr>
<td>What will the pattern be?</td>
<td>Keep going up by then count dots</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Need (Information needed to solve)</th>
<th>Solve (Show your work)</th>
</tr>
</thead>
<tbody>
<tr>
<td>7th fig. dots</td>
<td>28</td>
</tr>
</tbody>
</table>

On several occasions since September, we have used QPNS to help in the multi-step problem solving process. In the following space, I would like you to express your opinion of the strategy. Do you like or dislike the strategy? Why or why not?

It's alright but I don't tend to use it.

It does make me break the problem down but it also confuses me, and takes me longer to do. I just don't really like it.
As part of a probability experiment for his science class, Dylan randomly picks a marble from the bag and then replaces it. He repeats this 300 times.

**Dylan's Bag of Marbles**

<table>
<thead>
<tr>
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</tr>
<tr>
<td>Blue</td>
<td>3</td>
</tr>
<tr>
<td>Black</td>
<td>1</td>
</tr>
</tbody>
</table>

Dylan randomly picks a marble from the bag. What is the probability the marble will be red? \( \frac{8}{15} \)

Predict the number of times out of 300 Dylan will pick a red marble.

<table>
<thead>
<tr>
<th>Question?</th>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>(What is the question?)</td>
<td>(Strategies)</td>
</tr>
<tr>
<td>Predict number of times out of 300</td>
<td>( 300 \times 8 = 2400 )</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Need</th>
<th>Solve</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Information needed to solve)</td>
<td>(Show your work)</td>
</tr>
<tr>
<td>Red = 8</td>
<td>( \frac{2400}{300} = 8 )</td>
</tr>
<tr>
<td>300 times</td>
<td>2400 - 240 = 2160</td>
</tr>
<tr>
<td>15 marbles</td>
<td>( \frac{2160}{15} = 144 )</td>
</tr>
</tbody>
</table>

\[ \frac{2400}{300} = 8 \]

\[ +3 + 1 = 2 \]
How many dots will be in the 7th figure if the pattern continues?

\[ 1 + 3 + 6 + 10 + \ldots \]

<table>
<thead>
<tr>
<th>Question?</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(What is the question?)</strong></td>
</tr>
<tr>
<td>How many dots will there be if the pattern continues?</td>
</tr>
<tr>
<td>7th Figure!</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Strategies)</strong></td>
</tr>
<tr>
<td>Add 4</td>
</tr>
<tr>
<td>3 + 4 + 5 + 6 + 7</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Need</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Information needed to solve)</strong></td>
</tr>
<tr>
<td>20 dots Altogether the last pattern has 10 dots</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Solve</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>(Show your work)</strong></td>
</tr>
<tr>
<td>[ 3 + 4 + 5 = 12 ]</td>
</tr>
</tbody>
</table>

On several occasions since September, we have used QPNS to help in the multi-step problem solving process. In the following space, I would like you to express your opinion of the strategy. Do you like or dislike the strategy? Why or why not?

I like the QPNS because it helps solve the problem so you can take it step by step.
References


