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Improving Students' Story Problem Solving Abilities

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Abstract

In this action research study of my classroom of 8th grade mathematics students, I investigated if learning different problem solving strategies helped students successfully solve problems. I also investigated if students' knowledge of the topics involved in story problems had an impact on students' success rates. I discovered that students were more successful after learning different problem solving strategies and when given problems with which they have experience. I also discovered that students put forth a greater effort when they approach the story problem like a game, instead of just being another math problem that they have to solve. An unexpected result was that the students' degree of effort had a major impact on their success rate. As a result of this research, I plan to continue to focus on problem solving strategies in my classes. I also plan to improve my methods on getting students' full effort in class.

The purpose of my research is to improve students' abilities solving story problems. I wanted the students to learn different strategies by which they can solve most story problems they encounter in mathematics. I also wanted to discover whether students who had experiences with the topic of the story problem were more likely to solve the problem correctly. The main purpose of my research is to help students become more comfortable with story problems and to have a better attitude about their capabilities of solving story problems.

In my classes right now, the students' confidence in solving story problems is very low. Their success rate on solving story problems is very low compared to where I would like to see it. In class, there were far too many questions about the story problems that were on their assignments. The majority of the questions dealt with how to set the problem up and what the question was asking. The students appeared to understand the concepts that were in the lesson because they did fine with the typical drill problems that were on their assignments.

Problem Statement

I wanted the students to become better problem solvers after doing this research project. I wanted them to be more comfortable with solving problems in mathematics regardless of their level of knowledge. I also wanted to build their confidence in their ability to solve story problems. I think confidence is the largest factor because if students do not believe they are good at something or cannot do it at all, they usually will have a very difficult time. If I can build the students' confidence, then they will start to believe in themselves, and this will improve their problem solving ability.

This topic is important to all teachers for a couple of different reasons. I wanted the students to take the strategies that I taught them and use these strategies in other classes like science, computers, etc. I also wanted them to develop this skill so they can be more comfortable dealing with situations they will encounter as they become adults. For example, I wanted the students to be able to understand the fine print on advertisements that says no interest until 2008 and understand that if a person did not pay the entire amount by the date he would owe all of the back interest. I believe students are better citizens and consumers if they have better problem solving skills.

Literature Review

The main reason I chose this research topic is that I believe that students, for the most part, are good at drill and practice problems because they memorize the routine and know the exact steps to take. Loef-Franke (1997) researched 6 classrooms from both middle class and lower income schools and found that teachers who stress the process of story problems instead of just teaching what steps to take have more success. Students in these classes valued being able to justify and explain how they obtained their answers. As Loef-Franke states: "Children have typically viewed mathematics as a set of rules and procedures in which problems are solved by applying computational algorithms that have been explicitly taught by the teacher" (p. 8). When students come across problems that are out of the regular routine, they have a hard time with starting the problem or relating it to the knowledge they already possess.

Another reason I chose to improve students' problem solving abilities is that students need to learn multiple ways to approach problems. Problem solving is needed in real life, such as in being able to determine an alternative route if there is a detour on the

way to a destination. The student will need to know how to deal with this and find another route. Montague (2000) studied 54 middle school students ranging from learning disabled to gifted to see if the knowledge of different strategies helped students achieve more. Montague found that all students need to have multiple strategies to get a story problem started so that they do not give up so quickly. As Montague states:

> The good problem solvers used more strategies overall and more problem representation strategies specifically as problems became more difficult. Thus, the problems were differentiated with respect to a need for more and different strategies, which is evidence of their construct validity (p. 224).

This is why I chose to focus on teaching students multiple strategies to solve story problems. The strategies that I focused on were drawing a picture, making a table, and using guess and check.

Another reason I chose this topic as my action research project is that I do not think that problem solving is emphasized enough in mathematics textbooks. In my district there are so many objectives to get through in a year that there is not a lot of time to study strategies for solving story problems. I hope that my research shows that problem solving is just as important as learning the drill problems of the objectives. Brenner (1997) studied six pre-Algebra classes at three different junior highs in California to find the teachers' impact on students' problem solving abilities. It was found that teaching representation skills helped students be more successful with word problems. As Brenner states:

> Although problem representation skills are crucial for student success in algebra, instruction in problem representation skills is not generally emphasized in

> prealgebra courses. This study provides clear and consistent evidence that instruction on problem representation skills can work; that is, students who receive representation training for function problems perform better than comparison students in creating and coordinating multiple representations of functions (p. 682).

The more strategies a student has the better the probability the student will be successful when challenged with a difficult problem.

Purpose Statement

My two research questions are: What effect does teaching and practicing different problem solving strategies have on student's ability to solve problems? What effect do students' life experiences have on correctly solving story problems? My purpose for doing this research project was to improve students' problem solving abilities. Many students do just fine on problems that are straightforward covering objectives from the class. However, when the questions are story problems the students seem to be intimidated and not very willing to try the problems on their own. In order to be an educated citizen and also to be able to successfully complete higher level mathematics classes, students need to develop different problem solving strategies.

Method

This research was conducted in my eighth grade mathematics classroom during the spring semester, 2007. The method that I used was the following. I gave the students a pre-test to assess their problem solving skills at the beginning of the research. I graded this pre-test using a rubric that gave points for students' effort and ability to come up with a correct solution. I also gave the students a survey to determine their feelings about math

and problem solving. Starting the week after the pretest, for six weeks I had the students solve a problem of the week that I collected. I graded these problems for correctness. At the end of the research project the students took a post-test that was the same as the pre-test except for one problem. I believed that this particular problem was too vague, so I created another problem, involving the same math topic, which was easier to understand. After the post-test, I had the students fill out the same survey that they had completed at the beginning of the project. One difficulty that I had with collecting my data was the large amount of students who were absent from class on Fridays, which was the day that I had them work on their problem of the week, pre-test, post-test, and surveys. It was very difficult to have all of the students do all of the instruments.

The first week of my research project I gave the students a survey to assess their feelings about math and problem solving (see Appendix A). On this survey I found that the most positive response was to the question about students trying different methods before giving up on a problem. This encouraged me since I had talked with the students throughout the year about not giving up and always trying their best. The question that had the lowest mean score dealt with whether the students liked to be challenged in math class. This was not a surprise to me since most students like to have a clear road to their goals and do not like a lot of obstacles. I was surprised that for all six of the questions the mean scores were between 3 and 4 on a scale of 1 to 5. The other four questions were the following: “I like math.” “I am good at math.” “Knowing how to solve story problems is important to my future.” “I am more able to solve story problems if I understand and have had experience with the situation in the problem.”

On the Friday of the first week I gave students a pre-test. See Appendix B for the pre-test, various students' responses to the pre-test, and test score results. I wanted to determine their problem solving skills before I started the action research. I also wanted to see what problem solving strategies they had before I started concentrating on teaching them other strategies. I used a rubric with 0 points given for no work or the wrong answer with no work, 1 point for multiple mistakes, 2 points for having one mistake, and 3 points for a correct answer with correct justification.

On the pre-test the students were the most successful with the following problem: A fitness club charges $50 to get a membership, and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member? Another problem with which the students were very successful was the following: At Barton High School, 45 students are taking Japanese. This number has been increasing at a rate of 3 students per year. The number of students taking German is 108 and has been decreasing at a rate of 4 students per year. At these rates, when will the number of students taking Japanese equal the number taking German?

I believe that the students were the most successful on these two problems because they are very similar problems, and they were able to make charts to find the answers. We had worked a lot with making charts to find the answer before I started the research project in February. This showed me that the more experiences the students had with a certain type of problem the more likely they were to be able to obtain a correct solution. This gave me hope that this research project could have very positive effects on the students. The other two problems on the pre-test were about how many different ice cream cones one could order at a store and about laying sod on a rectangular field.

The problem I chose for the first week was about how many apples a prince will have after visiting three trolls. See Appendix C for the problem and one student's answer to the problem. On this problem sixteen out of the twenty-four students had a correct solution. Of these sixteen students, about half worked backwards from the answer to the question. There were some papers where it was obvious they had just gotten the answer from the person next to them. I knew this because they had the correct answer but none of their work to justify their answers.

The problem I chose for the second week was a game where they had to put six numbers around a triangle so that all three of the sides had the same sum. See Appendix D for the problem and several students' answers to the problem. On this problem fifteen out of the twenty-six students had a correct solution. The strategy used exclusively on this problem, regardless of whether the students had the correct solution or not, was guess and check.

The problem that I chose for the third week was about a boat in the ocean and how far it got blown off course by the wind. See Appendix E for the problem and several students' answers to the problem. On this problem eleven of twenty-three students had the correct solution. All of the students with the correct solution used the Pythagorean Theorem, and of those with the correct solution, five drew a right triangle. The most common incorrect answers were 70 and 170, which come from either just adding or subtracting the two numbers in the problem.

The problem I chose for the fourth week dealt with how much grass seed it would take to cover a soccer field. See Appendix F for the problem and several students' answers to the problem. On this problem nine of seventeen students had a correct

solution. Of these nine, all nine drew a picture of a rectangular soccer field. Six of these students converted the dimensions from yards to feet in the first step because the amount of grass seed needed to be measured in square feet. Of the students who had incorrect answers, four had no work or just drew a rectangle. The other students who missed the problem had a difficult time converting between square yards and square feet.

The problem I chose for the fifth week was about how much paint it would take to paint a shed. See Appendix G for the problem and several students' answers to the problem. Only four out of twenty-two students had the correct solution for this problem. All four of the students with the correct solution found the area of the four sides they needed to paint (front, back, left, and right) and added those together. The most common two mistakes were finding the volume of the shed and adding on the area of the roof and floor which did not need to be painted.

The problem I chose for the sixth week asked how many jerseys a soccer team could have if there were 3 different jerseys, 2 different shorts and 2 different colors of socks. See Appendix H for the problem and several students' answers to the problem. On this problem fifteen out of twenty-three students had a correct solution. Of these fifteen, eleven realized they could just multiply the three numbers together because of the counting principle to obtain the answer. The other four who had a correct solution either drew a picture or made a list of the possible uniforms.

On the Friday of the seventh week I gave students the same test they had taken at the beginning of the research. See Appendix I for the post-test, several students' answers to the post-test, and the test score results. The only difference between the pre-test and the post-test was that I changed number two to a different problem dealing with the same

concept. This was because problem two on the pre-test was too vague and did not have enough information. I used a rubric with 0 points given for no work or wrong answer with no work, 1 point for multiple mistakes, 2 points for having one mistake, and 3 points for a correct answer with correct justification.

On the post-test the students were the most successful with the following problem: A fitness club charges $50 to get a membership, and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member? The two strategies that I saw used the most were filling out a table and finding out when the money ran out and setting the problem up like a check register and keeping track of the amount of money left. This was the same problem with which the students had been the most successful on the pre-test.

The problem that was missed the most on the post-test was the following problem: A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park? The most common error on this problem was the students' difficulty converting between square feet and square yards. On almost every single paper I saw the students multiplying the length and width together to get the area, which was nice to see. I saw some students leave the answer as 5400 square feet and forget about the units being wrong. I also saw many students divide by 3 instead of 9 to convert from square feet to square yards.

The results of the survey taken at the end of the research project (See Appendix J) showed me that the students enjoyed math class and thought they were pretty good at math. The numbers in these categories had risen since the beginning of the research. I

was pleased with seeing this, and I hope that their enjoyment of math continues to stay high in future classes. The lowest two means resulted from the questions about liking to be challenged in math class and how being able to solve story problems is important for their futures. I was disappointed to see that at the end of the study students did not gain more of an appreciation for why learning how to solve story problems is important. Maybe as they get older and have more life experiences they will realize the importance of this skill.

On the question at the end of the survey concerning the students' favorite strategies to solve story problems, the most popular three responses were: drawing pictures, circling important words, and using guess and check. On the question about the students' least favorite thing about story problems the most popular responses were: the problems take too long, the problems are too hard, and the problems are difficult because of the reading.

Findings

From the data that I collected I learned that problem solving is a topic that should be emphasized in all classrooms. My first research question was, "What effect did teaching and learning problem solving strategies have on students' abilities to solve problems?" I found through my research that students had a much better success rate on types of problems they had seen or worked through before compared to types of problems they had not seen before. I observed this by assessing the students' success rate on the pre-test with the problems that could be solved by setting up a table. This was a skill that we had practiced many times during class throughout the year before I started the action

research project. On the pre-test, I clearly saw the students using a table in one form or another on the first problem to obtain the correct solution.

I also observed students using knowledge they had learned in class on the story problem about the boat sailing in the ocean (see Appendix E). In this problem the students used the strategy of drawing a picture or using their imaginations and seeing the right triangle in their mind. By doing this they were able to obtain a right triangle, and this allowed the students to know to use the Pythagorean Theorem. This is shown by the student work in Appendix E. The students who found the correct solution had a picture of a right triangle on the paper, and one must have known it was a right triangle and used advanced skills to properly use the Pythagorean Theorem.

Another strategy I saw the students use effectively to find the correct solution was making a list to find the total number of soccer uniforms that could be made (see Appendix H). This was a strategy that I saw students use when they forgot they could use the counting principle to obtain the answer. This is shown in Appendix H with the student who made a list of the twelve combinations. It was interesting to see the number of students who started making a list when I increased the number of possibilities on the post-test with the locker combination problem. I saw the students start the list, but soon stop. This was probably because there were 1000 combinations, and it would have taken a very long time to make the entire list. Only a few of the students made the connection between the beginning of their lists and the counting principle.

My other research question was, "What effect did students' life experiences have on correctly solving story problems?" I believe that if students have seen a type of problem before or have experienced it themselves they are more likely to obtain the

correct solution. I found that the students did better on problems that they had experience with throughout this project. On the problem about finding the area of a soccer field, the students were successfully able to draw a rectangle for the shape since they knew this from their experiences. If I would have asked the students to find the area of an object they had never seen before they would have been less likely to be able to set up the problem. Even though the success rate on this problem wasn't very high, the students did know how to find the area of a rectangle.

Another type of story problem the students were successful with dealt with money. For example, both the pre-test and post-test contained the problem about how many months one could be a member of a fitness club. From the examples of student work in Appendix B, I saw students treat this problem like they were keeping track of the amount of money in a bank account. This is a skill that students are taught in elementary school when they keep track of how many objects they have. I also saw one student figure out how much money was left after joining and then divide that number by how much it cost to be a member for a month. I believe that when the story problems dealt with money, it increased the students' interest in finding the solution.

Usually in class the students had a lot of questions about what they were supposed to find in the story problems presented in the book. The students asked very few questions throughout the project about what they were supposed to find in the respective problems. This does not mean they always got the correct answer, but at least they had an idea of what they were trying to determine.

Another interesting observation I noticed was that if students thought of the problem as a game they put in a much better effort. I saw this when the students were

working the triangle game problem, which is the problem that takes the most amount of work; all of the students were working until they had all the answers. I even had to take some of the students' papers at the end of class before they were finished because they were still working on getting the four solutions. This was in contrast to many of the other story problems where if students didn't know how to get the solution they would just either quit or write an incorrect answer that was very quick to find. For example on the problem with the soccer field some students just added the two numbers in the problem and left that for an answer.

Another observation I noted during the research project was that I found that the students needed a lot of help when converting between different units of measures. I had not anticipated that this would be a major issue. This showed up on both question 4 on the pre-test and post-test and on the weekly problem about buying grass seed to cover a soccer field. I believe that by concentrating on unit conversions for a couple of days and then having a weekly problem about it the students would do a lot better on the post-test with this concept. The mean score did go up about half a point, but the mode stayed at 1. I saw many students still writing their answers in square feet instead of square yards, and dividing by 3 instead of 9 to convert from square feet to square yards. I believe that part of the issue is that some of the students had a hard time with reading comprehension, and they forgot what the units of measure were in the problem.

Conclusions

I believe that my findings should show other teachers how important it is to teach students how to solve story problems. I knew from first glance that the problems throughout my research looked like they should be relatively easy for eighth graders.

However, the results clearly showed that students need a lot of help in this area. I also found that students give a better effort when they like the story problem and approach it as a challenge. I clearly saw this with the triangle problem by the amount of work and time the students put into this problem. I believe if you can challenge the students in a positive way and give them problem situations that they can put themselves in, they will give a much better effort.

It was also very important to choose story problems to which the students could relate and about situations with which they are aware. This was especially important for students who do not have good reading or comprehension skills. Many students got lost on story problems because there were too many words, and they could not understand what was being asked. This was one of the most cited reasons for why my students do not like story problems. This was not surprising because students who are in the lower math classes are also the students who are in the remedial reading classes.

I wanted my students after they left my class to be better students, not just in math but also in all subjects. One of my jobs was to help students be able to find their own way through situations in school and those in life that they might run across. Sometimes a problem could be as simple as knowing how to deal with other people that they might not like. Chapman (1997), in a two-year study of three teachers, showed that problem solving should not just be taught as a series of steps. After observing the teachers an average of eight times, it was found that teachers who explained story problems in their own perspective compared to just using the steps in the textbook had students more capable of solving story problems correctly. As Chapman states, "The primary purpose of

mathematical problem solving instruction is not to equip students with a collection of skills and processes, but rather to enable them to think for themselves" (p. 202).

Implications

An implication of my research is that all teachers should make a concentrated effort at improving students' work ethic. The largest problem that I saw while conducting my research was the lack of desire to do well in too many of my students. They seemed to work and try their best only when they felt like it. If they were interested in the problem or they were having a good day, they put forth a much better effort. I believe a question that needs to be answered is, "How can teachers get the best effort out of students?" This issue needs to be addressed as early as pre-school in my view. By the time the students get to eighth grade many of their behaviors and attitudes are firmly set.

In my classroom next year and in future years I need to find a way to encourage students to do their best. I believe that I am already a positive teacher who is good at encouraging students. I need to increase the number of times I praise students for their efforts. I am also considering some reward system, like giving a piece of candy or a sticker to students who are truly trying their best. My philosophy of education is that I want all students to work to the best of their ability. I need to find some original ideas to make this happen.

I know that many teachers say that they do not have time to concentrate on story problems. I felt the same time crunch as I was going through this project. I believed that it was very important for me to pick a certain day of the week and time of that given day to go over problem solving activities. Without having that organized, I would have had a hard time remembering each week to cover problem solving strategies and giving

assessments. By the end of the research project it became part of my routine for planning a week and made making time for discussing story problem strategies much simpler. I would also highly recommend that teachers choose problems that are about topics that the students have had experiences with and not feel confined to choosing problems that are in the curriculum that is being covered at the time. I do not believe the problems need to be overly complicated for the students' problem solving skills to improve.

I am going to share my research results with the other math teachers at my school at the beginning of the next school year in our Professional Learning Community (PLC) meetings. From the results of my research I believe it is clear that students, by improving their problem solving skills, increased their skills in math class in general. I am excited to see the growth in the students when I begin to put an emphasis on problem solving at the beginning of the year, instead of waiting until February.

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Appendix A

Problem Solving Survey

Please give your honest response to each statement, 1 being low and 5 being high.

1. I like math.	1	2	3	4	5
2. I am good at math.	1	2	3	4	5
3. Knowing how to solve story problems is important to my future.	1	2	3	4	5
4. I am more able to solve story problems if I understand and have had experience with the situation in the problem.	1	2	3	4	5
5. I like to be challenged in math class.	1	2	3	4	5
6. I try different methods to try to solve a story problem instead of giving up after trying one method.	1	2	3	4	5

COMPLETE THE FOLLOWING STATEMENTS .

7. My favorite strategy to solve story problems is:

8. My favorite story problem topic is:

9. My least favorite thing about story problems is:

The results of the survey taken before the research project started were the following: Twenty-six students took this survey.

Question 1: I like math.

Mean: 3.58 Standard Deviation: 1.27 Mode: 5

Question 2: I am good at math.

Mean: 3.81 Standard Deviation: 0.90 Mode: 4

Question 3: Knowing how to solve story problems is important to my future.

Mean: 3.54 Standard Deviation: 1.14 Mode: 4

Question 4: I am more able to solve story problems if I understand and have had experience with the situation in the problem.

Mean: 3.58 Standard Deviation: 1.14 Mode: 3

Question 5: I like to be challenged in math class.

Mean: 3.27 Standard Deviation: 1.18 Mode: 4

Question 6: I try different methods to try to solve a story problem instead of giving up after trying one method.

Mean: 3.92 Standard Deviation: 0.93 Mode: 4

Appendix B

Math 8 Story Problems Name:_____

1) At Barton High School, 45 students are taking Japanese. This number has been increasing at a rate of 3 students per year. The number of students taking German is 108 and has been decreasing at a rate of 4 students per year. At these rates, when will the number of students taking Japanese equal the number taking German?

2) An ice cream parlor has 8 different flavors of ice cream. You would like a dish with 3 scoops of different flavors. How many different dishes can you pick?

3) A fitness club charges $50 to get a membership and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member for?

4) A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park?

Math 8 Story Problems Name:

1) At Barton High School, 45 students are taking Japanese. This number has been increasing at a rate of 3 students per year. The number of students taking German is 108 and has been decreasing at a rate of 4 students per year. At these rates, when will the number of students taking Japanese equal the number taking German?

Japanese	German
45	108
48	104
51	100
54	96
57	92
60	88
63	84
66	80
[illegible]	76
[illegible]	72

10 years

2

2) An ice cream parlor has 8 different flavors of ice cream. You would like a dish with 3 scoops of different flavors. How many different dishes can you pick?

24

0

3) A fitness club charges $50 to get a membership and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member for?

260 - 50 = 216

216 ÷ 30 = 7

7 months

3

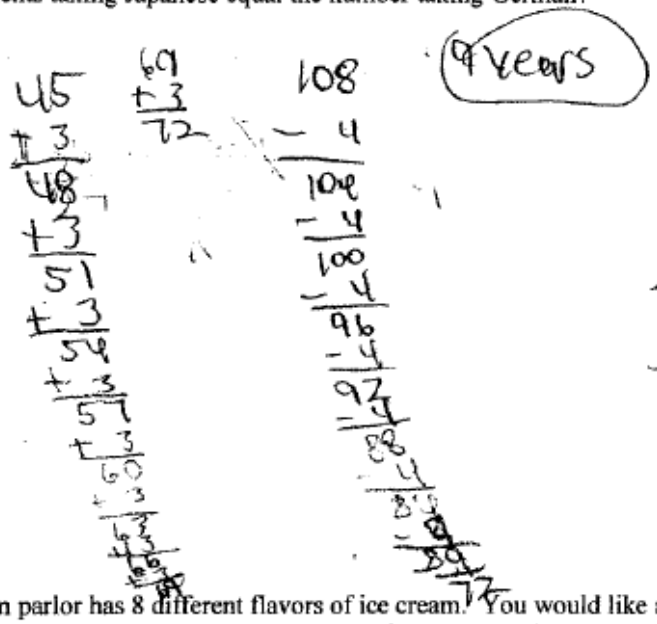
4) A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park?

90 feet = 30 yards
60 feet = 20 yards

30 • 20 = 600 yards^2

Math 8 Story Problems Name:_

1) At Barton High School, 45 students are taking Japanese. This number has been increasing at a rate of 3 students per year. The number of students taking German is 108 and has been decreasing at a rate of 4 students per year. At these rates, when will the number of students taking Japanese equal the number taking German?



2) An ice cream parlor has 8 different flavors of ice cream. You would like a dish with 3 scoops of different flavors. How many different dishes can you pick?

$8 \cdot 3 = 24$

2

3) A fitness club charges $50 to get a membership and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member for?

$260 - 50 = 30x$

$\frac{210}{30} = \frac{30x}{30}$

$7 = x$

7 months

3

4) A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park?

$90 \div 3 + 60 \div 3$.

$30 + 20$.

50 rolls.

1

Math 8 Story Problems Name:_

1) At Barton High School, 45 students are taking Japanese. This number has been increasing at a rate of 3 students per year. The number of students taking German is 108 and has been decreasing at a rate of 4 students per year. At these rates, when will the number of students taking Japanese equal the number taking German? = 9 years later

60 45 108 84

3-6 3-1 4-1 4-7

63 48 104 80

3-7 3-2 4-2 4-8

66 51 100 76

3-8 3-3 4-3 4-9

69 54 96 72

3-9 3-4 4-4

72 57 92

3-5 4-5

60 88

4-6

84

3

2) An ice cream parlor has 8 different flavors of ice cream. You would like a dish with 3 scoops of different flavors. How many different dishes can you pick?

8×3=24

2

3) A fitness club charges $50 to get a membership and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member for?

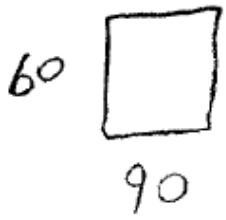
260
- 50
210
30 - 1
180
30 - 2
150
30 - 3
120
30 - 4
90
30 - 5
60

$60
30 - 6
30
30 - 7
0

7 months

3

4) A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park?



90
×60
5400

5400 ÷ 3 = 1800

2

Appendix B

22 students took this pre-test.

Question 1:

Mean: 2.36 Standard Deviation: 0.85 Mode: 3

Question 2:

Mean: 1.54 Standard Deviation: 0.74 Mode: 2

Question 3:

Mean: 2.59 Standard Deviation: 0.73 Mode: 3

Question 4:

Mean: 1.18 Standard Deviation: 0.73 Mode: 1

Appendix C

Golden Apples

A prince picked a basketful of golden apples in the enchanted orchard. On his way home, he was stopped by a troll who guarded the orchard. The troll demanded payment of one-half of the apples plus two more. The prince gave him what he demanded and set off again. A little further on, he was stopped by a second troll guard. Again the troll demanded payment of one-half of the apples the prince had (now) plus two more. The prince paid him and set off again. Just before leaving the enchanted orchard, a third troll stopped him and demanded one-half of his remaining apples plus two more. The prince paid him and sadly went home. He had only two apples left. How many apples had the prince picked? Explain your reasoning.

Golden Apples

A prince picked a basketful of golden apples in the enchanted orchard. On his way home, he was stopped by a troll who guarded the orchard. The troll demanded payment of one-half of the apples plus two more. The prince gave him what he demanded and set off again. A little further on, he was stopped by a second troll guard. Again the troll demanded payment of one-half of the apples the prince had (now) plus two more. The prince paid him and set off again. Just before leaving the enchanted orchard, a third troll stopped him and demanded one-half of his remaining apples plus two more. The prince paid him and sadly went home. He had only two apples left. How many apples had the prince picked? Explain your reasoning.

$2+2\cdot 2=8+2$ $10\cdot 2=20+2=22\cdot 2=44$

44 apples

44
-22
22
- 2
20
-10
10
- 2
8(
- 4
4
-2
2

Appendix D

The Triangle Game

Consider an equilateral triangle with points located at each vertex and at each midpoint of a side. (See picture.) This problem uses the set of numbers {1, 2, 3, 4, 5, 6}.

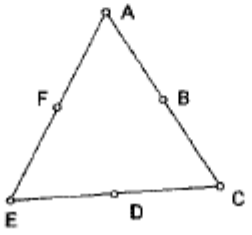
1) Find a way to put one of the numbers at each point so that the sum of the numbers along any side (two vertices and one midpoint) is equal to the sum of the numbers along each of the two other sides. (Call this number the "Side Sum.")

2) Is there more than one way to get the same Side Sum? (You may have to make a decision as to what it means for two "ways" to be different.)

3) Is it possible to have two different Side Sums?
   a. If yes, what is the smallest possible Side Sum and why?
   b. If yes, what is the largest possible Side Sum and why?

4) What Side Sums are possible? (Show by giving examples for each Side Sum.)

5) What is a possible generalization of The Triangle Game? Are you able to find any solution to your generalized game?



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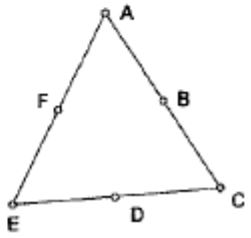

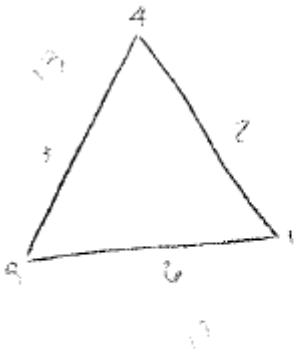

The Triangle Game

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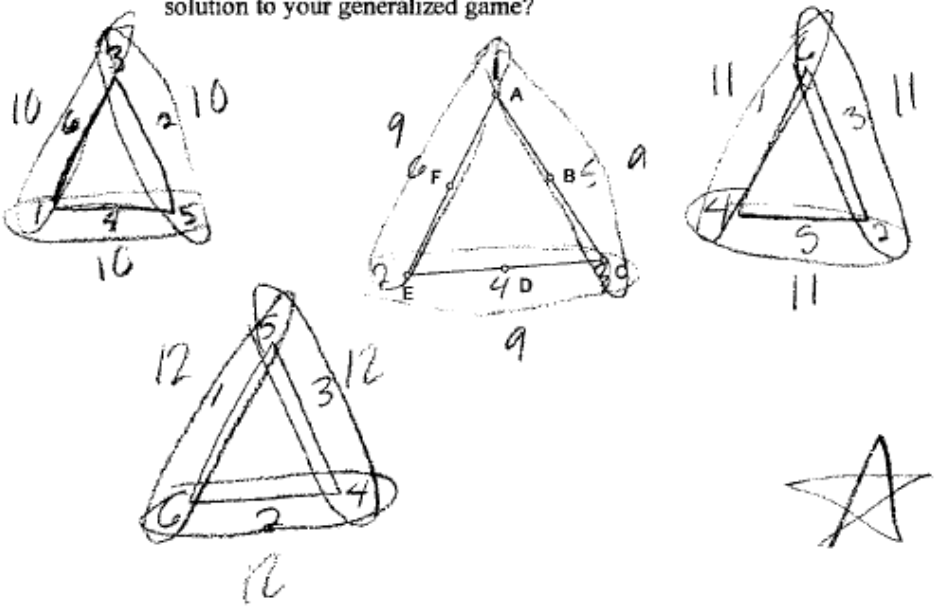

The Triangle Game

Consider an equilateral triangle with points located at each vertex and at each midpoint of a side. (See picture.) This problem uses the set of numbers {1, 2, 3, 4, 5, 6}. = 21

1) Find a way to put one of the numbers at each point so that the sum of the numbers along any side (two vertices and one midpoint) is equal to the sum of the numbers along each of the two other sides. (Call this number the "Side Sum.")

2) Is there more than one way to get the same Side Sum? (You may have to make a decision as to what it means for two "ways" to be different.)

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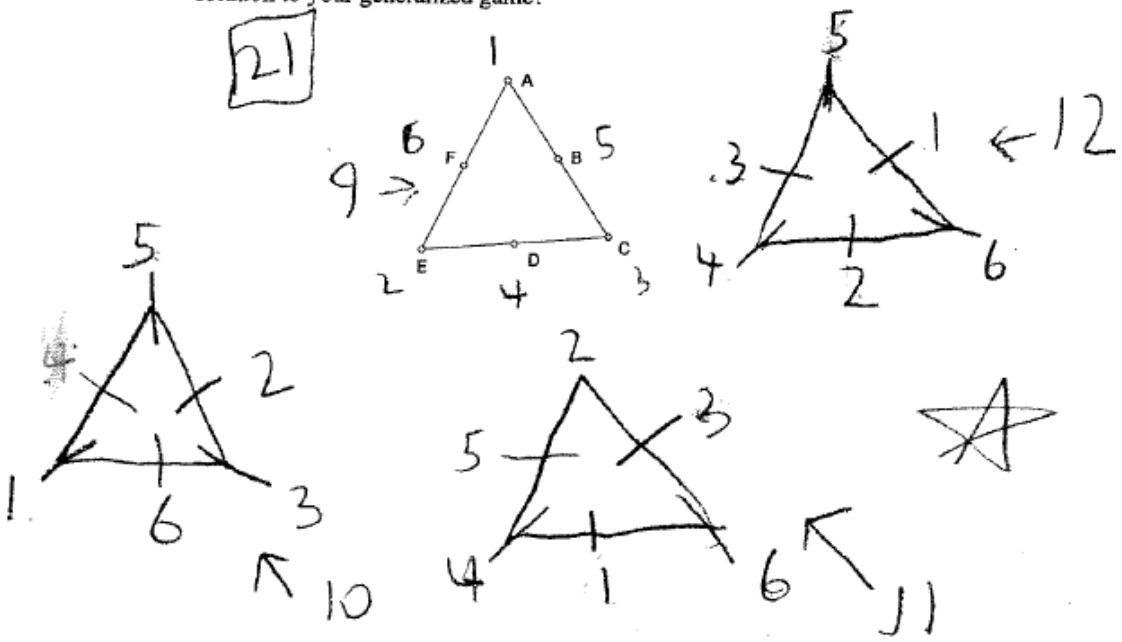


Appendix E

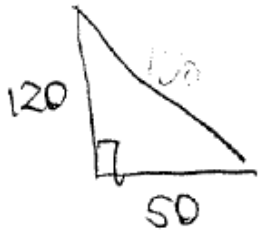
Math 8 Name: _____

1) A boat in the ocean is 120 miles directly north of a small island. The boat begins to head to shore but is pushed by a wind heading directly east. The boat ends up 50 miles directly east of the island. If the boat traveled in a straight line, how many miles did it travel?

2) If you double the base and height of a triangle, what happens to the area of the triangle? Explain your reasoning.

Math 8 Name:

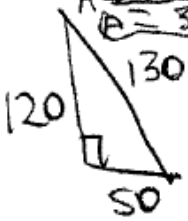
1) A boat in the ocean is 120 miles directly north of a small island. The boat begins to head to shore but is pushed by a wind heading directly east. The boat ends up 50 miles directly east of the island. If the boat traveled in a straight line, how many miles did it travel?



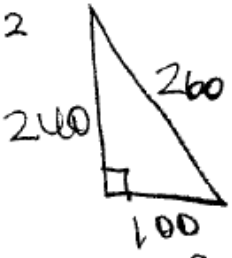
$120^2 + 50^2 = x^2$
$14400 + 2500 = x^2$
$16900 = x^2$
130 mi $= x$

2) If you double the base and height of a triangle, what happens to the area of the triangle? Explain your reasoning. The area gets bigger because of the numbers, and the Area gets 4 times bigger

$P = 130 + 50 + 120$
$P = 300$
$A = 120 \cdot 50 \div 2$
$A = 6000 \div 2$
$A = 3000$



$120^2 + 50^2 = x^2$
$14400 + 2500 = x^2$
$16900 = x^2$
$130 = x$



$240^2 + 100^2 = x^2$
$67600 + 10000 = x^2$
$67600 = x^2$
$260 = x^2$

$P = 240 + 260 + 100$
$P = 600$
$A = 240 \cdot 100 \div 2$
$A = 24000 \div 2$
$A = 12000$

Math 8 Name: _____ _____

1) A boat in the ocean is 120 miles directly north of a small island. The boat begins to head to shore but is pushed by a wind heading directly east. The boat ends up 50 miles directly east of the island. If the boat traveled in a straight line, how many miles did it travel?

$a^2+b^2=c^2$

$120^2+50^2=c^2$

$14400+2500=c^2$

$\sqrt{16900}=\sqrt{c^2}$

130 miles

2) If you double the base and height of a triangle, what happens to the area of the triangle? Explain your reasoning.

it would be greater because you doubled it.

Math 8 Name:

1) A boat in the ocean is 120 miles directly north of a small island. The boat begins to head to shore but is pushed by a wind heading directly east. The boat ends up 50 miles directly east of the island. If the boat traveled in a straight line, how many miles did it travel?

170 miles

120
50
170

2) If you double the base and height of a triangle, what happens to the area of the triangle? Explain your reasoning.

Appendix F

Math 8 Name:_____

A soccer field is 120 yards long and 80 yards wide. You are asked to go to the store and buy grass seed to improve the condition of the field. Your boss tells you to buy 30 pound bags of grass seed and that each bag will cover 10,000 square feet. How many bags of grass seed do you need to buy from the store?

For a Jolly Rancher if you get it right, if each bag of grass seed costs $20, how much are you going to have to pay for the grass seed before tax?

Math 8 Name:

A soccer field is 120 yards long and 80 yards wide. You are asked to go to the store and buy grass seed to improve the condition of the field. Your boss tells you to buy 30 pound bags of grass seed and that each bag will cover 10,000 square feet. How many bags of grass seed do you need to buy from the store?

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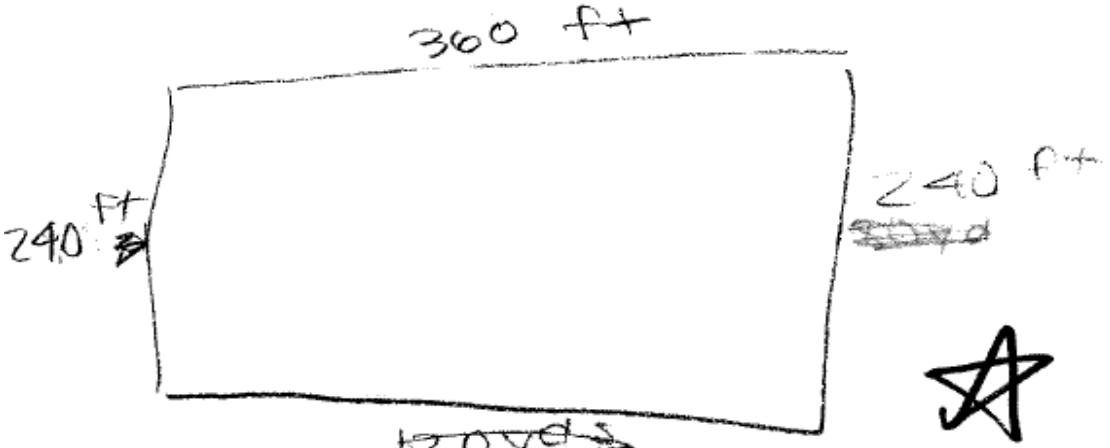


A · b · h
A = 360 · 240
A = 86400 ft

9 bags

$180.00

Math 8 Name:_

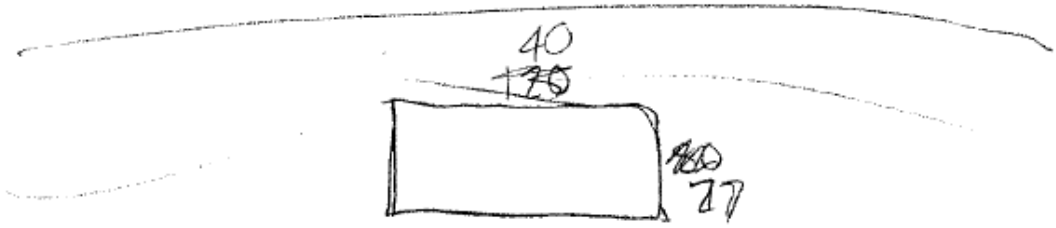
A soccer field is 120 yards long and 80 yards wide. You are asked to go to the store and buy grass seed to improve the condition of the field. Your boss tells you to buy 30 pound bags of grass seed and that each bag will cover 10,000 square feet. How many bags of grass seed do you need to buy from the store?

For a Jolly Rancher if you get it right, if each bag of grass seed costs $20, how much are you going to have to pay for the grass seed before tax?

3

400 ft. x 27 ft

10,800



1080

Appendix G

Math 8 Warmup Name: _____

You need to paint a shed that is shaped like a rectangular prism (box). The top of the shed already has shingles on it, so it does not need to be painted.
Its dimensions are:
Length: 10 feet
Width: 8 feet
Height: 9 feet

1) How many square feet do you have to paint? (think carefully)

2) If one can of paint covers 250 square feet, how many cans of paint do you need to buy?

Math 8 Warmup Name:

You need to paint a shed that is shaped like a rectangular prism (box). The top of the shed already has shingles on it, so it does not need to be painted.
Its dimensions are:
Length: 10 feet
Width: 8 feet
Height: 9 feet

324ft²

1) How many square feet do you have to paint? (think carefully)

324ft²

2) If one can of paint covers 250 square feet, how many cans of paint do you need to buy?

2 cans of paint.

Math 8 Warmup Name:

You need to paint a shed that is shaped like a rectangular prism (box). The top of the shed already has shingles on it, so it does not need to be painted.

Its dimensions are:
Length: 10 feet
Width: 8 feet
Height: 9 feet

90 + 90 + 72 + 72 + 80 + 80

1) How many square feet do you have to paint? (think carefully)

484 ft2

2) If one can of paint covers 250 square feet, how many cans of paint do you need to buy?

2 cans

Math 8 Warmup Name:

You need to paint a shed that is shaped like a rectangular prism (box). The top of the shed already has shingles on it, so it does not need to be painted.
Its dimensions are:
Length: 10 feet
Width: 8 feet
Height: 9 feet

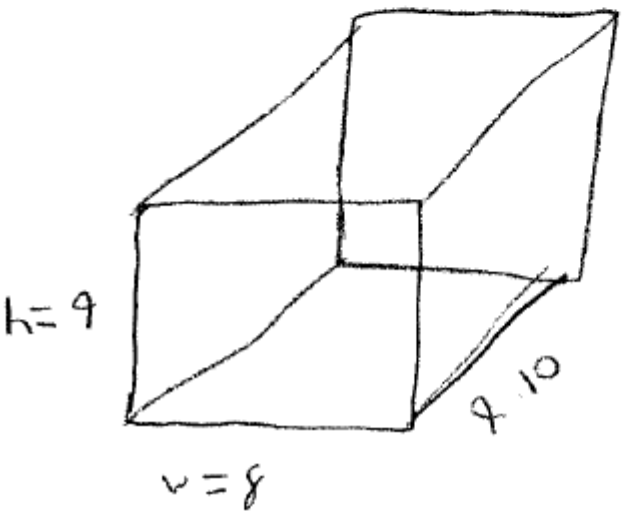
10 · 8 · 9
10 · 72
720

1) How many square feet do you have to paint? (think carefully)

720 ft^2

2) If one can of paint covers 250 square feet, how many cans of paint do you need to buy?

3 cans of paint



Appendix H

Math 8 Name: _____

You have just been selected to be on a soccer team. On this team they have many different uniforms they can wear for a game. There are 3 jerseys the team could wear (red, black, white), 2 colors of shorts (red, white) and 2 different colors of socks (black and white). How many different uniforms does your coach have to choose from to wear for a game? (Don't worry about style, just how many possibilities there are.)

Math 8 Name:

You have just been selected to be on a soccer team. On this team they have many different uniforms they can wear for a game. There are 3 jerseys the team could wear (red, black, white), 2 colors of shorts (red, white) and 2 different colors of socks (black and white). How many different uniforms does your coach have to choose from to wear for a game? (Don't worry about style, just how many possibilities there are)

red, red, Black
red, white, Black
red, red, white
red, white, white

black, red, Black
black, white, white
black, red, white
black, white, white

white, red, Black
white, white, Black
white, red, white
white, white, white

34

12 uniforms

Math 8 Name:

You have just been selected to be on a soccer team. On this team they have many different uniforms they can wear for a game. There are 3 jerseys the team could wear (red, black, white), 2 colors of shorts (red, white) and 2 different colors of socks (black and white). How many different uniforms does your coach have to choose from to wear for a game? (Don't worry about style, just how many possibilities there are)

3·2·2 12 uniforms possible

Appendix I

Math 8 Story Problems Name:_____

1) At Barton High School, 45 students are taking Japanese. This number has been increasing at a rate of 3 students per year. The number of students taking German is 108 and has been decreasing at a rate of 4 students per year. At these rates, when will the number of students taking Japanese equal the number taking German?

2) A combination lock has 10 numbers on it (0 through 9). The lock's combination has three numbers. For example 8 – 4 – 2. How many different combinations are there?

3) A fitness club charges $50 to get a membership and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member for?

4) A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park?

Math 8 Story Problems Name:

1) At Barton High School, 45 students are taking Japanese. This number has been increasing at a rate of 3 students per year. The number of students taking German is 108 and has been decreasing at a rate of 4 students per year. At these rates, when will the number of students taking Japanese equal the number taking German?

J	G
45	108
48	104
51	100
54	96
57	92
60	88
63	84
66	80

J	G
66	80
69	76
72	72

10 years

2

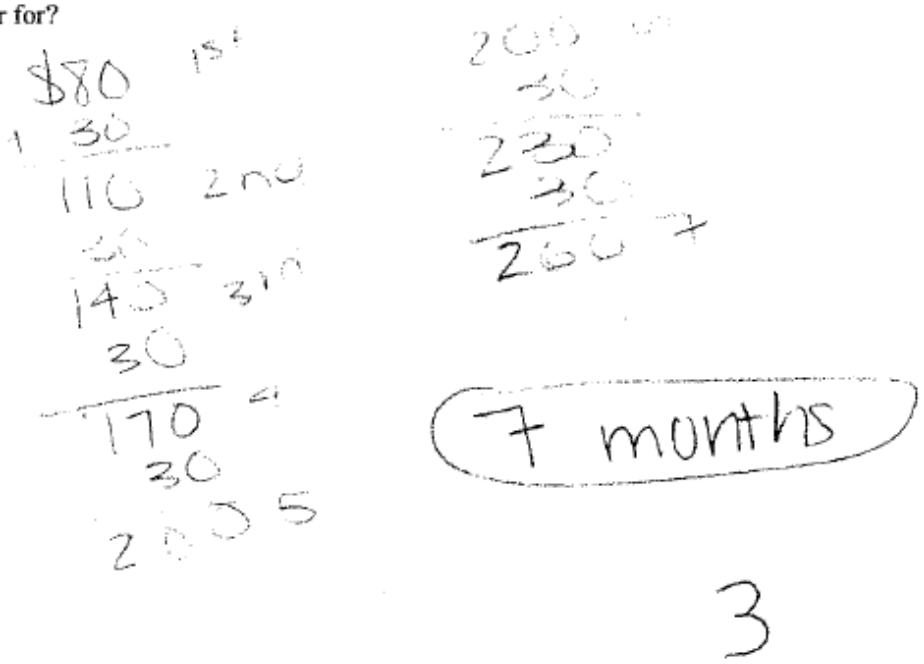
2) A combination lock has 10 numbers on it (0 through 9). The lock's combination has three numbers. For example 8 – 4 – 2. How many different combinations are there?

10 · 10 · 10

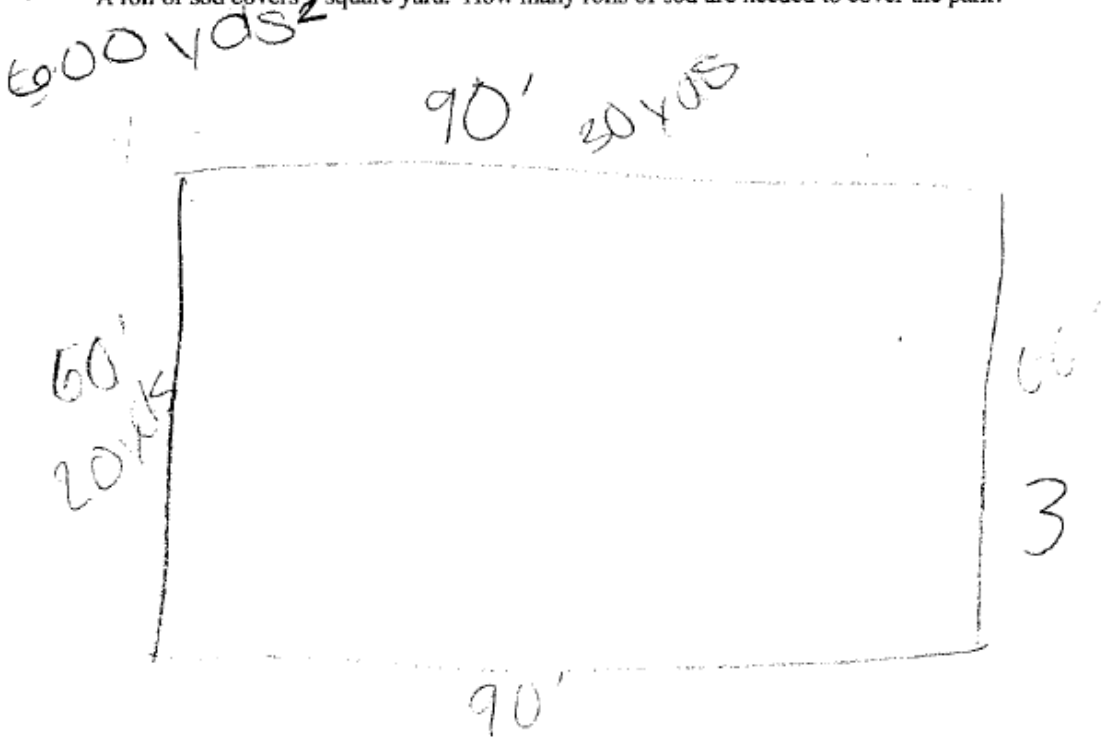
1,000 different

3

3) A fitness club charges $50 to get a membership and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member for?



4) A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park?



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Japanese	German
45	108
48	104
51	100
54	96
57	92
60	88
63	84
66	80
69	76
72	72

9 years

3

2) A combination lock has 10 numbers on it (0 through 9). The lock's combination has three numbers. For example 8 – 4 – 2. How many different combinations are there?

1	1	1
1	2	1
1	3	1
1	4	1
1	5	1
1	6	1
1	7	1
1	8	1
1	9	1

10 · 9

90 combinations

2

3) A fitness club charges $50 to get a membership and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member for?

260
- 50
210

30 | 210 (7)

7 months

3

4) A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park?

90 · 60

5400 ft

90 ft

60 ft

3

30 yds

20 yds

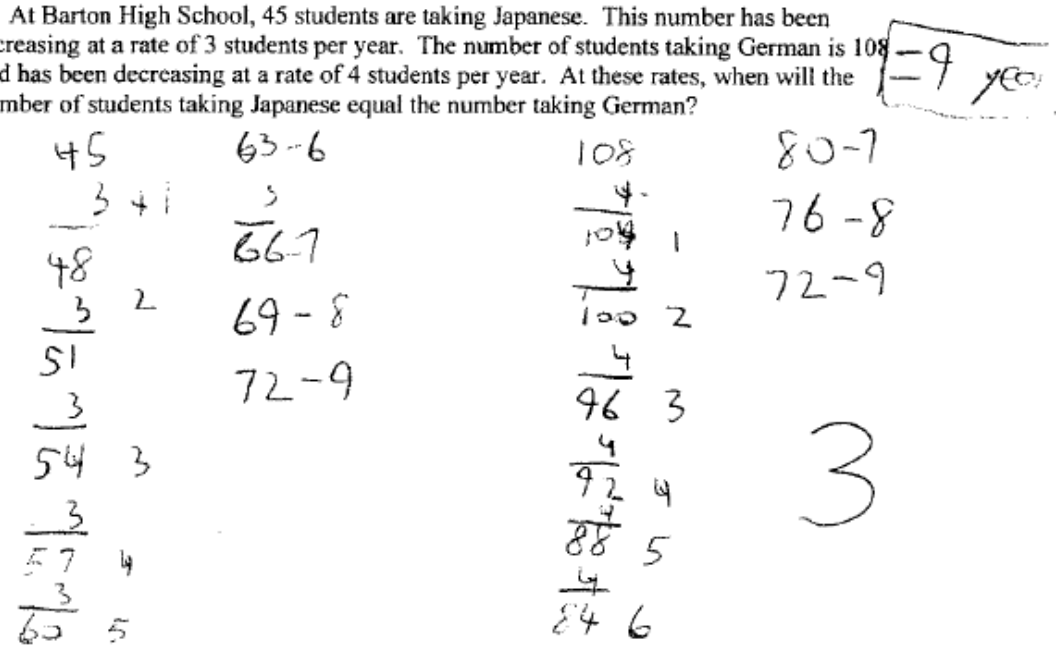
30 · 20

600 sq yds

600 rolls

Math 8 Story Problems Name:

1) At Barton High School, 45 students are taking Japanese. This number has been increasing at a rate of 3 students per year. The number of students taking German is 108 and has been decreasing at a rate of 4 students per year. At these rates, when will the number of students taking Japanese equal the number taking German?



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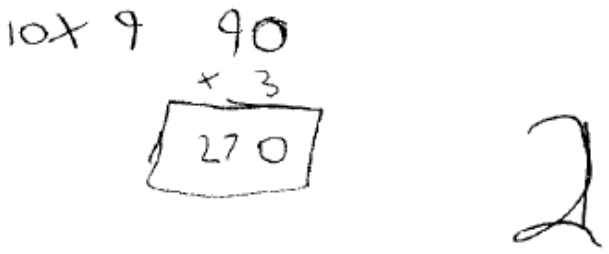

3) A fitness club charges $50 to get a membership and it costs $30 a month to use the club. You have $260 to spend on belonging to the fitness club. How many months can you be a member for?

3 210
-30 1
180
-30
150 - 2
-30
120 - 3
-30
90 - 4
-30
60 - 5

60
-30
30 - 6
-30
0 7

7 months

3

4) A rectangular park that is 90 feet long and 60 feet wide needs to be planted with sod. A roll of sod covers 1 square yard. How many rolls of sod are needed to cover the park?

90 x 60

5602 yd

1.

23 students took this post-test.

Question 1:

Mean: 2.00 Standard Deviation: 0.67 Mode: 2

Question 2:

Mean: 1.78 Standard Deviation: 0.85 Mode: 2

Question 3:

Mean: 2.52 Standard Deviation: 0.73 Mode: 3

Question 4:

Mean: 1.61 Standard Deviation: 1.03 Mode: 1

Appendix J

Survey given at the end of the project:

Seventeen students took this survey.

Question 1: I like math.

Mean: 4.00 Standard Deviation: 1.00 Mode: 5

Question 2: I am good at math.

Mean: 4.29 Standard Deviation: 0.77 Mode: 5

Question 3: Knowing how to solve story problems is important to my future.

Mean: 3.53 Standard Deviation: 0.80 Mode: 4

Question 4: I am more able to solve story problems if I understand and have had experience with the situation in the problem.

Mean: 3.94 Standard Deviation: 1.03 Mode: 4 and 5

Question 5: I like to be challenged in math class.

Mean: 3.53 Standard Deviation: 1.28 Mode: 5

Question 6: I try different methods to try to solve a story problem instead of giving up after trying one method.

Mean: 3.94 Standard Deviation: 0.97 Mode: 5