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A Study of Written Communication: Showing Your Steps

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A Study of Written Communication: Showing Your Steps

Abstract

In this action research study of my teaching of sixth grade mathematics, I investigated the importance of showing work on daily assignments. I wanted to find out what happens when I ask students to show their work, specifically, whether it would improve students' grades or not and whether I could help the students to understand the importance of showing their work. I discovered that students need to be shown the proper way to show their work, how to look at a problem and then how to show all of their steps to get to the answer. They need to be encouraged and be held accountable for showing their work when asked. Once they were able to show work, they could start to see the value in showing their work and they tended to show their work more often. Students became more confident in themselves as mathematics students and, in some cases, their grades improved. As a result of this research, I plan to teach and explain to my future classes about how showing their work can benefit them in a variety of ways. They will be able to use the knowledge that they gain in my classroom in their future math classes in middle and high school.

Introduction

Showing work or showing steps is a concept that students just do not seem to want to do anymore. Currently, it seems that school and schoolwork is put on the back burner and sports, video games, and hanging out with friends get top priority. “Why do we have to do it,” and “it takes too long” are just a few comments that I hear every single day being an elementary mathematics teacher. I only have been teaching for four years but I hear these comments every year. I also teach fourth and fifth grade mathematics as well and I do not hear it as much in my fourth grade class, but I start to hear it more in fifth grade and then comes sixth grade where school just does not seem as important anymore. They are growing up, their out of school interests are growing, and so schoolwork gets set aside.

It seems that students in my 6th grade classroom want the easy way out when it comes to doing any sort of work. I do not want to classify the whole class with the word lazy, but that word comes to mind when I think about some of my 6th grade mathematics class. Some complain when I ask them to show their work or when I give them something new to do, (for example, math stations containing one problem a day that can cover a wide range of topics). They complain and say they do not understand how to do the work before they even finish reading what they are supposed to do. The students are always telling me what they have to do when they get home so, in their minds, they do not have enough time to do their homework. When I give them time to do work in class, they speed through it as fast as they can so they do not have to take any work home. When I am walking around and asking why I only see answers and not any work to support their answers they tell me that they can do it in their heads so there is not any point in showing their work.

I was getting frustrated hearing that same answer over and over so that is when I decided to do my research on the importance of showing work and hoping to have the students realize why it is important to show their work even if they can do it in their head. The work that I want my students to be able to show is the procedural steps that they take to get to an answer. If they know what they are doing, then it should not take them much longer to write the steps down.

When I was a student, mathematics came easy to me. I could do a lot of it in my head so I can relate to my students. But as I got older, I had to push myself to show my work so later I could go back and look at what I had done. It helped my teacher know that I knew the steps to get to an answer. It also helped when I did struggle that I had notes and examples to go back and look at to help me with the problem I was working on.

Elementary school is a critical time in a child's life. Children learn many things throughout their whole school career, but elementary school is where they get their base, where they learn the fundamentals to make it in society. If students cannot learn the basics in elementary school, then high school and beyond could be challenging for them.

As I started thinking about my research and how I was going to go about conducting it, I tried to brainstorm some different strategies or techniques that I could try. Some strategies could be to reward students for showing their work or have a consequence if they do not show their work. Elementary students like tangible awards; they like to have something to show for the work that they have done. I could also model more what showing work looks like. I could do more problems on the board or have students walk me through what they think a problem should look like. I could give them blank paper instead of paper with boxes on it to designate where the students' work should be done at so they do not think they can only work in a limited amount of space. I do not think this is the greatest of ideas since my students are used to having the box

paper since the 4th grade and once in awhile students would use lined paper if they forgot the box paper and they would try to fit the whole problem on one of the lines. I wanted them to have the paper that they were comfortable with. One other thing that I could do is give them all the answers to their homework and then grade them on the work they show. That would then force them to show work, when possible. What I decided to do was pick certain problems from their homework, grade those problems based on the work they show, and then average that grade with the original grade on the homework. I decided to take this approach because I wanted the students to show their work but I did not want to grade all 30 problems for 20 students every day based on work shown. That would take up too much time. In addition, since this was new to the students, I did not want to overwhelm them right away. I also wanted to include their original grade since they did put effort into doing their assignment.

In my ideal classroom, I would have all of my students showing their work so I know where a certain answer comes from. I would like to be able to look at students' papers and be able to follow their train of thought. Seeing their work would show whether they have some understanding of the problem or not. Some could be very good guessers if all they do is put answers. I would also see my students trying something new that is expected of them and maybe actually looking forward to some new way of working in math class instead of doing the same thing day after day. They would also be able to write about what they were doing or learning. I would like my students to do what is asked of them without expecting some sort of reward at the end. I would like them to have the self-motivation and the self-satisfaction of doing something on their own without being rewarded. I would hope that the students know they are doing what they are supposed to be doing and doing a good job at it and that a good grade would be reward enough. However, it seems for most of my students grades are something they do not care about

yet. I hear time and time again that their elementary school grades will not affect them in the future. Or, that they cannot be held back in elementary school just because they are not passing a certain subject. I try to tell them that their grades can affect them and their school career but again at this age it does not seem to matter yet.

Being a teacher, one has to make sure everything one does is aligned with a state or national standard. Teachers seem to be always rewriting curriculum or assessments so they align with the standards so children are getting an equal education. A NCTM standard that I see my research fitting into is the reasoning and proof standard. Children at a young age can learn how to explain how they got a certain answer. It can be informal at first but as they get older and learn new strategies, their reasoning and proof will become more systematic. They might start out by doing some trial and error work or work that just makes sense to them and, by showing their work, different strategies will become easier for them to explain to a teacher or a peer. They would not have to do a lot of talking if they show it all in their work; a teacher will be able to see what they were thinking. On the other hand, they will be able to explain it better to a peer if the student shows all of their work. I am not going to be focusing on the whys of the problems but in being able to do the steps; if students are asked to explain the problem further, they will have a better understanding of the problem if they can walk through it step by step. This research is a beginning stage for me as a teacher. Once my students are able to show steps when solving problems, the next thing will be to push them on their reasoning or why they solved a problem a certain way. Having the students reason why they solve problems certain ways will get to the heart of this standard.

Another standard I see this problem of practice fitting into is the communication standard. Communication is essential in math whether it is verbal or written. Showing work will

help students organize and consolidate their mathematical thinking. It will also let the teacher see more of what they were thinking and how they were thinking. Showing work would also help the students evaluate their thinking and the strategies they use to complete a problem. If the student solves a problem and then goes back and looks at it, they might see that there could have been an easier way to solve the problem or they could have started it in a different way.

Problem Statement

Having sixth grade students like math and want to do math is important since they still have many years ahead of them left in school. I just want to prepare them for the upcoming years in school and the future in general. I like students to show their work because it helps me know that they are grasping the concepts that are being taught. In addition, it helps the student see where or how they made their mistakes if they make any. It is easier to fix the problem when one knows right where someone may have gone wrong in the steps they followed. I want all children to like school and want to learn new things, not feel that they are being forced to do things. Forcing a student is going to make them not like school and not want to do what is asked of them. They need to believe that they are making the right choices for themselves.

Throughout this research process, I hope to understand how children learn and understand mathematics. I hope my research will show me some of what students are thinking and how they are approaching certain problems. If they are all doing a problem a certain way and still not understanding it, it will show me that I need to teach it another way because the first method was not a huge success. I will then be able to share my results with colleagues who might have the same frustrations that I do when it comes to students and the lack of showing work. I am hoping to see connections between better understanding and better explanations and better grades when students show their work. I hope it becomes habit for them instead of

something they dread doing. I want students to be able to show their work without even thinking about it or questioning if they should or not. I want them to think of it as part of the problem, that they are not just searching for a right answer but doing the whole problem from start to finish.

Communication is an important part of life whether it is verbal communication or written communication. Students know they are going to have to write in their English classes so why should they not expect to have to write in their mathematics classes. According to the NCTM standards, mathematics is divided into two sections, procedural and conceptual. In my classroom, I do not see enough of their procedural understanding so it is important for the students to know what numbers and what steps they need to use to get to their final solution. It is one thing to verbally tell a teacher how one got an answer when asked, but it is just as important to be able to show work on paper. I am not saying students have to write paragraphs while doing their math homework. I want them to just show me how they got their answer to a particular problem. If they can show and explain their work in math, I hope that it will carry over into other subjects and benefit everyone around. I want students to have the confidence that they can find their way to a correct answer whether it be looking for an answer in science by writing down what they know first and then going through steps to get the answer they are searching for or by being more descriptive when they are in their writing class. There are numerous ways to show work but I am looking for if they can write down the steps they are thinking in their head onto paper. My first step with my students is that I want them to be able to procedurally work through a problem and then as they get better at that, I will begin to teach them to start answering questions conceptually.

Literature Review

There have been some research studies conducted around the topic of written communication and the importance of it. For instance, Neria and Amit (2004) say, "Reform in mathematics education emphasizes written communication as a tool to develop and deepen mathematical thinking and reasoning" (p.413). Also Moskal and Magone (2000) say,

> The examination of students' written responses for the mathematical systems that are employed (referents), the connections that are displayed (relationships) and the communication methods that are utilized (modes) provides evidence that suggests how the student is making sense of the problem (p. 313).

These authors believe that written communication is important. They also believe it is a gradual process that will eventually lead to a deep understanding of mathematics. My goal is to get the students to take the first steps in deepening their understanding by showing their steps to get to an answer.

One theme around written communication is the students' knowledge and beliefs of mathematics. Students have to be able to communicate how they feel and what they know about mathematics. Star (2002) says,

> Current reform efforts and research are primarily focused on the type of understanding commonly referred to as 'conceptual understanding.' In doing so, we have lost sight of the critical importance of another kind of mathematical understanding—that which underlies procedural competence (p. 2).

He also says, "Current work lacks an emphasis on <u>doing</u> mathematics – in other words, using and understanding the mathematical procedures and skills that are an essential part of our discipline" (p. 2). Students have to show their steps to understand the procedures before they can focus on the conceptual part of mathematics.

He goes on to note that,

> Planning knowledge of a procedure takes into account the order of steps, the goals and sub-goals of steps, the environment or type of situation in which the procedure is use, constraints imposed upon the procedure by the environment or situation, and any heuristics or common sense knowledge which are inherent in the environment or situation. Within Hiebert's framework, this type of knowledge does not fall nicely into either conceptual knowledge or procedural knowledge. In essence, teleological semantics is conceptual knowledge about a procedure—it is both procedural and conceptual knowledge. It is knowledge, which is rich in relationships, but where the relationships in question are abstract and are among procedural steps. (p. 7)

Similar to Star, I also believe that it is important for students to know how to do a problem procedurally before they can begin to understand it conceptually. There has to be a nice balance to both kinds of learning to help students get a well-rounded mathematics education.

Kloosterman, Raymond, and Emenaker (1996) conducted a three-year study on students' beliefs of mathematics. They asked the students questions regarding achievement, beliefs, group work, and usefulness of mathematics. They found students were consistent over time about how much they liked school and mathematics, how important it was to learn mathematics, their confidence in learning mathematics, and their notions about all students being able to learn mathematics. The latter finding is important because it shows that, in contrast to claims that some students believe they cannot do mathematics (National Research Council, 1989) in some schools, most students realize that anyone who tries is able to learn mathematics. Kloosterman, Raymond, and Emenaker note,

> Our major interest is in how beliefs influence student motivation and achievement, and beliefs about self are key. We found that most students believe that anyone can learn mathematics and that confidence, once formed, seems fairly stable. We found that students think mathematics is useful, even if they cannot give many reasons why. And we found that the challenge may actually lead students to enjoy mathematics more. (p. 52)

Talking with my students is going to be one way that I gain information about what they are thinking and feeling about mathematics. I need to tell students they can do well in math so they start believing it themselves.

Another theme in the literature around written communication is errors and what types of errors are being made. Clements (1982) said, “Using Newman’s interviews revealed that over 20% of the errors made on the MAMP test were careless, in the sense that the students knew how to do the questions and there were no obvious reasons why they had erred” (p. 42). He also said, “That the number of careless mathematical errors correlates negatively with arithmetical and mathematical language competence and positively with misplaced mathematical confidence” (p. 42). He notes, "Mathematically competent and confident children, who know that they know, tend to make a greater proportion of careless errors than other children” (p. 43). Blando, Kelly, Schneider, and Sleeman (1989) found that a small number of errors, particularly precedence (order of operation) errors, were common across students. They say, “Teachers should teach a mathematical rule by using many different formats, so that students can more readily learn that rule abstracted from one format may not apply in another” (p. 306). Watson (1980) talks about how interviews are helpful to see what kinds of errors students are making. He says,

> Interviews are also helpful in that it forces the teacher to ‘hear’ the child doing mathematics. The teacher is not tempted to hurry the process by telling the child a way to

> get the answer so he can speak to Fred who is calling out that he wants help also. The child is not left with a rushed explanation that could be more confusing than enlightening. Even if it is not clear during the interview how a particular error should be classified, if the teacher has noted down what was done or said, that information can provide a firm base for giving the child further help. (p. 328)

Interviewing or just talking with my students is very beneficial. Not only do I get a sense of what they are feeling, I also get a grasp on what they are doing and I am then able to help them when they are struggling. Students also believe I care and want them to do well so then they decide to put in extra effort on their work.

Another theme found throughout the literature, which can tie in with errors, is assessment. There have been studies done on how to evaluate students' work done on different assessments. Krebs (2005) discusses a professional development activity for teachers to help analyze students' work. She says, "As the NCTM Standards implied, assessment should be a fundamental part of instruction, classroom teachers evaluating their instruction based on their perceptions of student learning" (p. 403). She asks, "How can educators become more adept at such "on your feet" assessment observations and responses? A first step is by working together closely to analyze students' thinking." She goes on to state, "Analyzing student thinking is not limited to studying written work. Additional data, such as listening to students while they work and ask questions about solutions, offer a more complete representation of students' understanding" (p. 403). Evens and Houssart (2004) did a study on students' written answers to a mathematics test question. They found that 8% did not attempt to answer the question. Another 24% gave wrong answers or focused on irrelevant factors. Two thirds of the students gave

correct answers. Evens and Houssart decided to look at three different categories of correct answers, which were restatement, examples, and justification. They stated,

> Many children were partway to providing a full answer, but needed more detail or precision. In many cases, the challenge for the teacher is in assisting children to express what they already know with more precision. Rather than providing 'model answers' to questions of this sort, teachers can build on the initial answers that children provide. (p. 282)

They also suggest,

> Many of the children providing incomplete justification may be helped by questions encouraging them to improve their answers. Comparison of several answers may also be fruitful. Children may be asked to consider which answers say essentially the same thing and where they differ. This may lead to judgments about what might constitute a good answer and draw attention to missing detail. (p. 282)

Questioning and comparing are two great ways to get children to think on their own and work towards the right answer. Students need to learn how to figure out the best way to get to an answer. Asking them questions or to compare different answers will help them focus on what they are looking for and lead them to the right answer.

Assessment is always ongoing and having different ways to assess students will give the teacher a better understanding of the students' understanding of mathematics. If teachers are not assessing properly, they will not be able to help the student answer the questions they are asking of them. The type of assessing I am doing with this research is looking at students' grades and asking them questions, whether in an interview, journal, or a survey. Looking at these

different things will help me better understand what my students are thinking and help them answer the questions I am asking them.

My research differs from the published research in different ways. For instance, my research involves sixth grade students, while the students in the literature are predominantly younger elementary students, with a couple studies focusing on high school students. In addition, while my research investigates students showing their steps in a procedural manner, most published research investigated students' mathematical reasoning in a conceptual manner. My next step in my own teaching is to look at how I can help my students learn the conceptual reasoning behind their problem solving, but I believe students need to learn the procedural steps before they can begin to learn the conceptual steps. This is just the beginning of what I want my students to learn and understand in my classroom before they move on to high school.

The importance of written communication should be studied to gain knowledge of how children learn and communicate their thinking process in mathematics. My research will look at the importance of students showing their steps when solving a mathematics problem. The literature agreed it is important for children to be able to communicate what they are thinking in a written form, but teachers have to be aware that students will be communicating at different levels and teachers may have to dig deeper with some students to really understand what they are trying to say. Krebs (2005) says, "Looking carefully at students' written work and listening carefully while students explore worthwhile tasks can contribute to a teachers' professional development" (p. 406). After all, is that not what research is all about; teachers helping themselves to better help their students. Therefore, I am going to look at how students show their work and help them realize the benefits of showing their work. If I can increase students'

understanding of what they are doing, I am, in turn, becoming a better teacher. I will be fulfilling my goal of helping my students become better mathematicians.

Purpose Statement

The purpose of this study is to explore the advantages of students' written communication. I will be looking to see whether grades improve when students show their work and whether careless errors will decrease when students show their work, therefore increasing their grade. I will also be looking to see whether the number of students showing their work will increase. Another thing that I will be looking at is if the students understand the importance of showing work and knowing that there are benefits to showing their work

My research questions are:

- What are the benefits of having students show their work?
- How will showing work affect students' grades?
- How do I help students to see the importance of showing their work?

Method

This action research was performed during the spring semester of the 2007 school year. The class consisted of 20 students, with 19 participating in the study. Of the 19 students from which data was collected, 10 were boys and nine were girls. Four of these students were classified as resource or special education students and two of those four students had special homework, which was a worksheet with helpful hints to accompany the problem sets from the book.

I began my data collection by giving out a survey to the whole class on February 21, 2007. I gave the same survey to them again on April 26, 2007 (See Appendix A). I made up the survey questions as a means of gathering data on how students felt about showing their work.

There were seven statements about their feelings on math and showing their work. They had to rate themselves by how strongly they agreed or disagreed with each of them. (See graphs in Appendix B) There were also eight statements about things they liked and did not like about math and if and why they thought showing their work is important. Once they filled out the survey, they were asked to put it in a manila envelope and were told that I would not look at them until the school year was over. I did not want the students to think that their answers would sway my thinking about them or have any influence on the math grade I would give them.

Another piece of data that I collected was pre and post interviews from seven students, who were randomly selected by another teacher in my building from those who gave consent to participate (see Appendix C). I interviewed the students the last week in February into the first week of March and again in the last week in April. I had to find time during students' recesses when both students and I were available, which was not always easy to do. I asked the same 12 questions in both interviews. I did not tape record the interviews but my students did not have a lot to say so I was able to write down everything they said. I was hoping to get honest responses and more in depth answers about their feelings on mathematics and showing their work since they did not have to write down all of their responses. I feel I did, based on the fact students were not in a rush to get outside and I had other students ask if they were going to be interviewed too. The students I interviewed did not seem shy about what they were telling me because not everything they said was always positive or what I was hoping to hear.

I started off copying all of the students' work once or twice a week, but I noticed that it was getting to be too much paper. I was not sure how or if I would analyze it all, so I decided to choose three or four students who I thought were doing a good job showing their work and three or four who were not showing their work as well as I thought they could. Once I had my seven

students picked out, I tried to copy their work at least once a week. We had achievement tests during this semester so I did not see my 6th grade class for a week and did not get a sample of their work during that time. I also kept copies of all the students' tests taken during the time I conducted the research.

On March 12, 2007, I started choosing five semi-random questions from their daily work and grading those based on work shown. They are semi-random because I had to make sure they were problems that students could show their work on. Then I averaged that grade with the original grade on the homework and recorded the two grades to see if the students' grades were increasing or decreasing. I did this for every child. Most days I told students I was going to pick five problems to grade them on in hopes they show their work for every problem since they did not know which problems I was going to pick. I stopped grading their homework this way on April 25, 2007 when I had a conflict with a set of parents.

One other kind of data I collected was journals from my students. (See journal prompts in Appendix D) I also wrote a few journal entries about what I was seeing in my classroom and the situation with the unhappy parents. Two of the journal topics I had the students write about that I thought pertained to the research included "why should you check your work" and "what have you learned or gained from Miss Kelly's research?"

This table describes the data I collected, how much and when. I have collected a variety of data throughout the time allotted for the research.

Data type	Dates collected	Amount collected
Surveys	2-21-07 and 4-26-07	2 per student
Interviews	2-26-07---3-7-07 and 4-26-07---5-3-07	14 total; 2 per student
Student journals	2-27-07---4-25-07	5 per student
Teacher Journal	2-27-07---4-25-07	1 every other week
Student Homework	2-21-07---4-25-07	9 assignments for 7 students
Grades	2-21-07---4-25-07	13 homework assignments and

		5 tests per student

This data helped me answer my three research questions.

I analyzed my data by trying to find common themes between students' answers in their surveys, interviews, and journals. I also looked at students' grades and made graphs to represent what I was seeing with their grades either improving or not improving. I was not able to collect all of the data (student homework) I intended because of the set of parents who were in disagreement with what I was doing. This research process had been stressful enough and then to add parents not being supportive, I decided to end my gathering of data on April 25, 2007. I had to choose what was more important to me between being a teacher or being a researcher and I chose being a teacher. I felt like I had a significant amount of student work, so I do not feel concluding my data collection a week early had any significant impact on my analysis and findings.

Findings

Recall my first research question was what are the benefits of having students show their work? My assertion is students understand why showing their work can help them. When I interviewed the seven students both in February and again in April, one of the questions that I asked was, "what are the benefits of justifying your answers on your homework assignments, if any?" They all said something to the effect, so they could understand the problem better and go back and check one's work. Specific answers are below. When I asked myself this question, I was thinking of similar responses, so this reaffirmed what I believed. I was glad to see the students understanding benefits to showing their work.

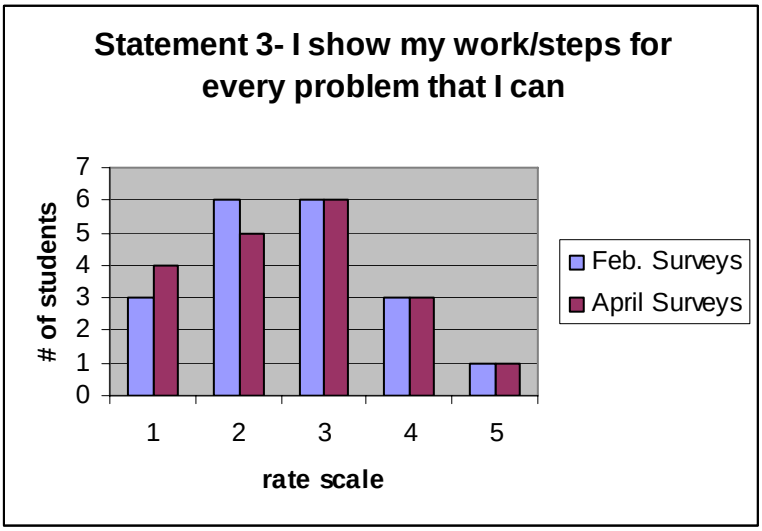
	Feb. Interview	April Interview
Bailey[1]	So I get the right answer, I understand it better	To help work out the problem

[1] All names are pseudonyms.

Erik	You can go and check it over easier	So you can check it over
Cory	Make you have better grades so if you did it right you have the right answer	Not really
Annie	So the teacher knows you know how to do it	So you can check your work then you can see where you messed up and fix it
Darla	Help you think it through	It helps you get the right answer most of the time
Kenzie	If you get it wrong you can go back and check and know why you got it wrong	If we get it wrong we can go back and check it
Matt	You can check if your problem is right	So you can check your work.

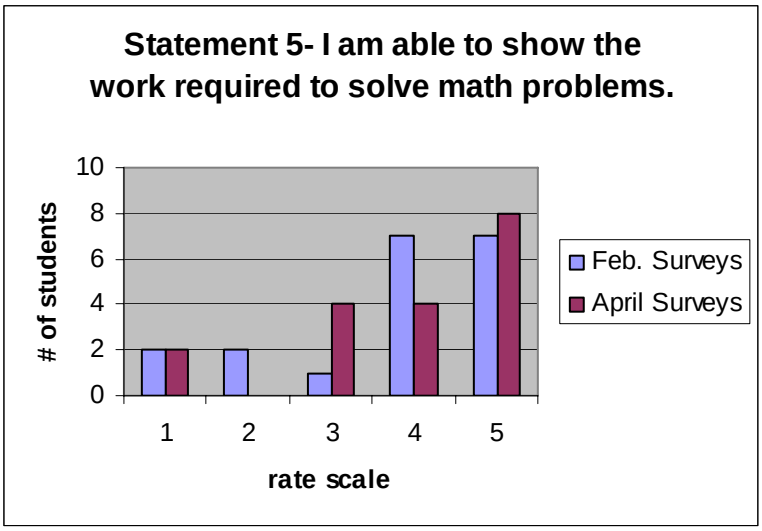
A journal the students were asked to write was, “Why should you check your work?” All of the students made mention of getting better grades, making fewer mistakes and having a better understanding of the problem. Brian summed it up the best by saying, “You should check your work because you’ll miss fewer problems, you’ll understand it better, you’ll be confident with yourself and you’ll do well in school” (3-12-07). If one looks at the journals, interviews, and surveys, most of the students had answers that sounded somewhat the same as Brian’s, even though it did not always come across in their actual grades. Not all of the students missed fewer problems or received better grades as a result of showing their steps. Nevertheless, Brian’s statement encompassed what the rest of the class seemed to believe.

A big idea I saw in the surveys and interviews is students admitting if they can or cannot show their work and that it is not always necessary, in their opinion, to show their work. I had seven statements the students rated, one being low to five being high, on how they felt about showing their work. One of the statements asked if they show their work on every problem they can.



As one can see, six out of 19 students chose a three which tells me that they felt they showed their work half the time and the other half they did not. This was true on both the February and April surveys. The numbers stayed the same for the ratings of four and five but reversed themselves on the rating of one and two. A reason I believe this happened was because on one of the open ended survey statements that asked students to write about why they do not like to show their work, 10 out of 19 said that it takes too long (February survey) and in the April survey all but four said because it takes too long. It has not become habit for them yet. I always encourage them to show their work, but I did not do anything about it until the study and even by the end, they were not used to the new expectations.

My next graph represents students' responses to the survey statement that asks the students if they are able to show the work required to solve math problems. Four students responded with a three in April compared to one student in February, and eight students gave themselves a five in April compared to a seven in the February survey. This information tells me more students are able to show their work now, though they may not like to all the time because it takes them longer than it used too. I was able to see this in their written work. Some students were showing more work and others were not.



Once I noticed students saying it was taking too long to show their work I wanted to look at what they said when they were asked if there are times when it is ok not to show your work. I asked this question in the survey and I asked a similar question to the seven students I interviewed. Here are the results from the survey and what the students said during the interviews.

February survey—is there a time when you should not have to show your work and if so when?

2/19 gave specific types of problems that do not need work shown.
4/19 say we should always show our work.
9/19 say when it is mental math or you can do it in your head.
2/19 say you should not have to show your work
2/19 say when I do not want to or when there is no homework.

April survey—is there a time when you should not have to show your work and if so when?

4/19 gave specific types of problems that do not need work shown.
3/19 say we should always show our work.
6/19 say when it is mental math or you can do it in your head.
6/19 say you should not have to show your work.

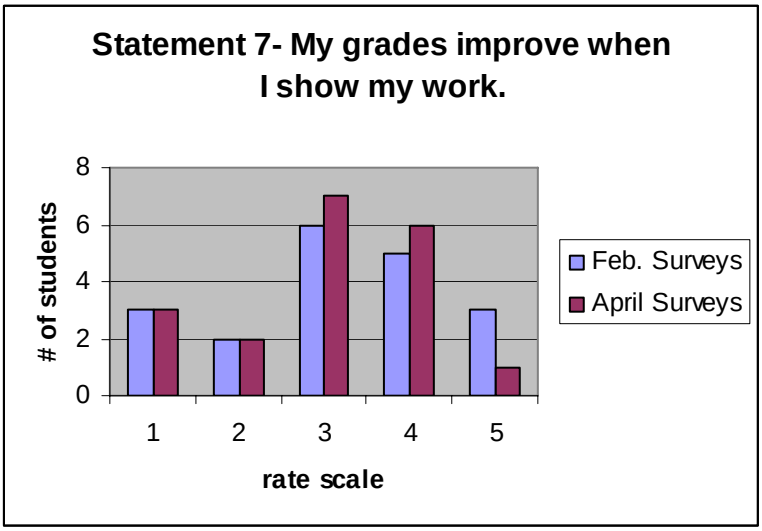
When do you think it is ok not to show your work?

	Feb. Interview	April Interview
Bailey	So if it's really easy	If the question is really easy if you can do it in your head
Erik	For doing a greater than less than problem	Greater than less than problems

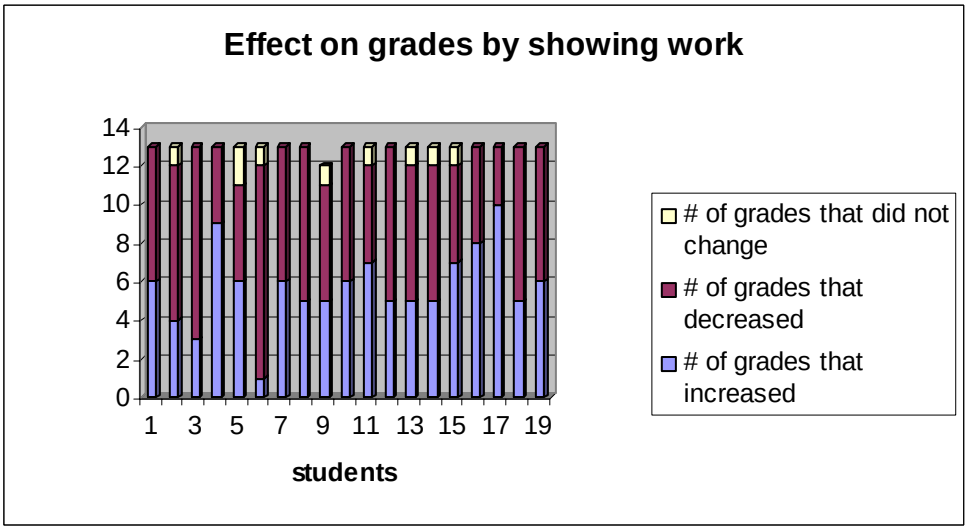
Cory	Easy questions like 2 plus 2	Easy problems when you can do it in your head
Annie	On mental math and fast facts	On fast facts
Darla	If it says do it in your head you should try it	When the lesson is teaching you to do it in your head
Kenzie	When you have to write a sentence about it or graph problems	Not really, I can't think of anything, if it is writing things like definitions or meaning
Matt	When it has the work for you ex. pictures	If they ask you a specific question on a chart or something

From this set of data, I noticed that about half of the students think not all problems need work shown, especially if it is a mental math problem or if it is a specific type of problem. They gave specific examples of problems that did not need work shown, like greater than/less than problems or finding decimal places. I am glad they can do these kinds of problems in their heads but it is still nice to see they understand where they are getting their answers.

Recall my second research question was how will showing work affect students' grades? My assertion is that their grades will improve. I was surprised with what I found. If one looks at the survey question that refers to grades improving, one sees that the majority of the students scored the statement a three or a four in both surveys, thereby telling me they thought their grades would improve.



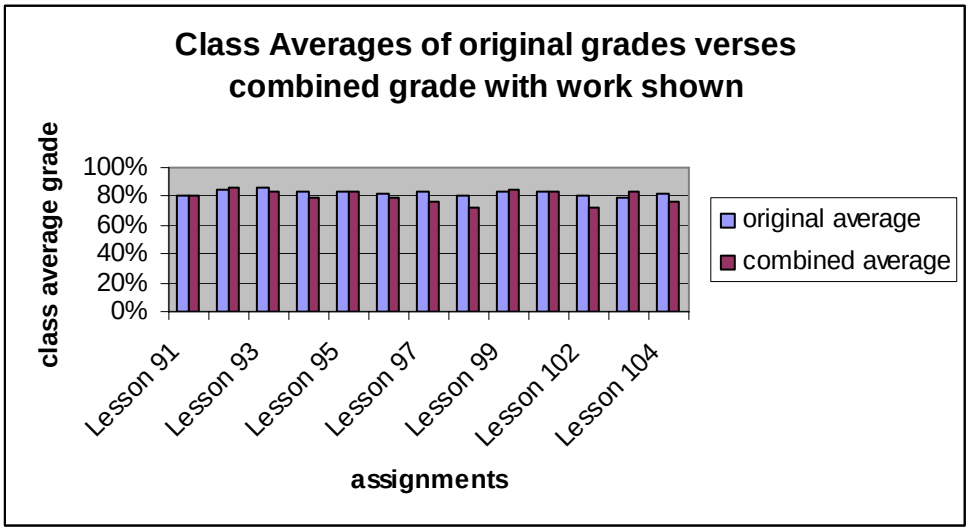
Now if one looks at their actual grades on their homework and tests, it is not actually the case for some of the students. I graded my students' homework like I always did and then I chose five homework problems from that homework and graded those based on working being shown and then averaged the two scores together. My first graph represents the affects on their grades by showing their work for all 19 of my students. I counted how many of their grades went up, down, or stayed the same.



As one can see, six of my students had more of their grades improve. For example, student four, had nine grades increase, which is represented by the blue and only four of the

grades decreased, which the red represents. If one looks at the grades that went down, for most of the students, one will see they do not go down by many points. If one looks at Sophie's, for example, her grades went from an 84 to an 82 or 89 to 85, or 97 to 96. There were a couple grades that had bigger gaps, but not many. (See records of Sophie's grades in Appendix E.) Even though the graph looks like many grades for some of the students decreased, taking a closer look at the individual grades, one can see that not all of them decrease by a big margin.

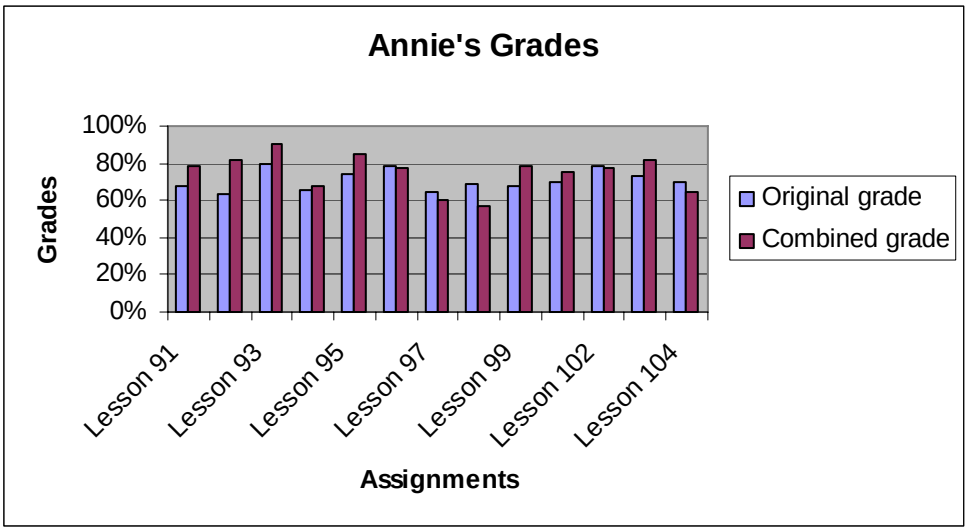
My next graph represents the class averages of original grades verses the combined grades on homework done during this research project.

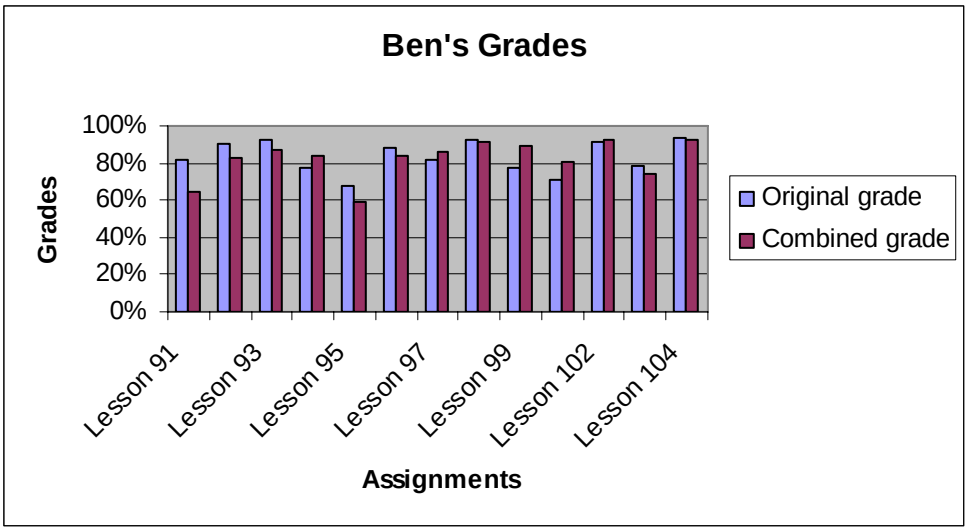


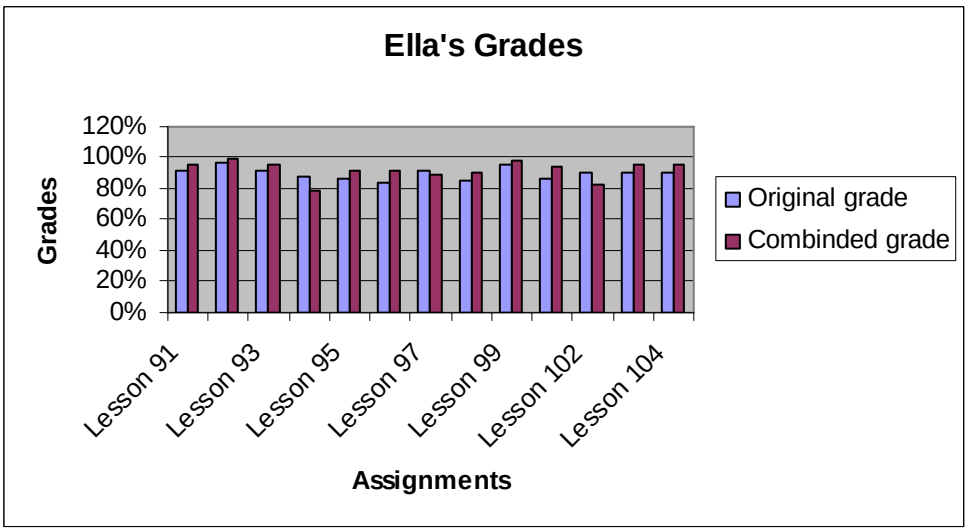
It does not look like there was a huge increase on grades when work was shown but the new grade was not a lot lower than the original grade either. They stayed relatively close. This shows me that showing work does not always improve students' grades, as one would hope, at least for the class as a whole. If one looked at each student's grade, you might see greater improvement. This graph could look very different if I had decided to grade all of their homework based on work shown instead of just five problems. I believe there would have been a greater difference between the original grade and the new grade. With practice and time, I

believe their grades will begin to improve, better than what I have seen in this short amount of time.

I then picked a high, medium and low student, grade wise, and graphed their grades on each assignment. I wanted to look at a more specific sample instead of the class as a whole. I wanted to see if a student shows their work, how it will benefit them. Annie would be considered one of my low students. She puts in a lot of effort but still struggles. Ben, I consider one of my medium students. He has the potential of being on the high end but does not put in a lot of effort. Ella is one of my high students. She is one who always tries for an A.



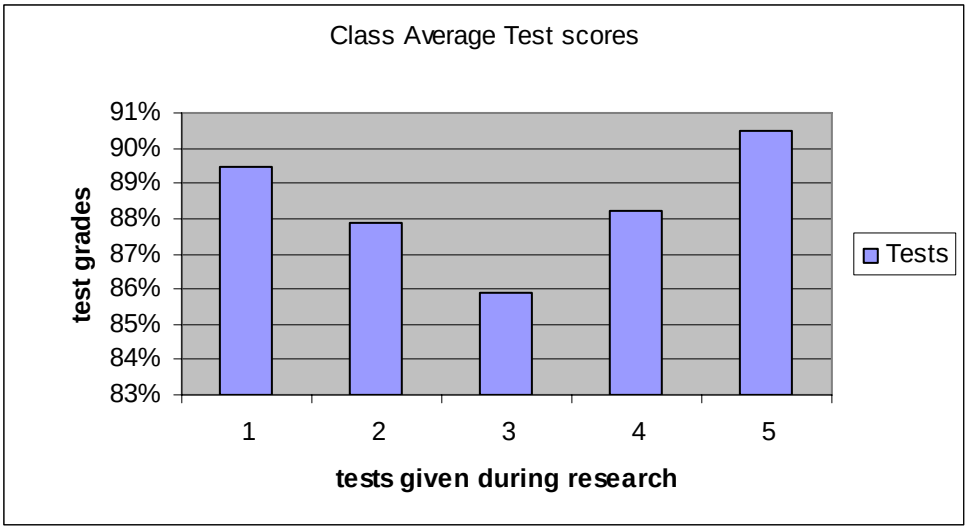




As one can see, showing their work improved at least half of their grades. If their combined grade did go down compared to their original grade, it did not go down by much as seen on the graphs above. On Annie's, for example, some of her grades went from a C to a B, which is major progress for her since she usually averages a C grade.

I also made a graph to represent the class averages on the tests that I had given during the research period. I did not grade the tests any special way, as I did the homework. One can see that the class average went down on a couple of tests but started to go back up after students started getting used to showing their work. The last test they took had the highest average out of

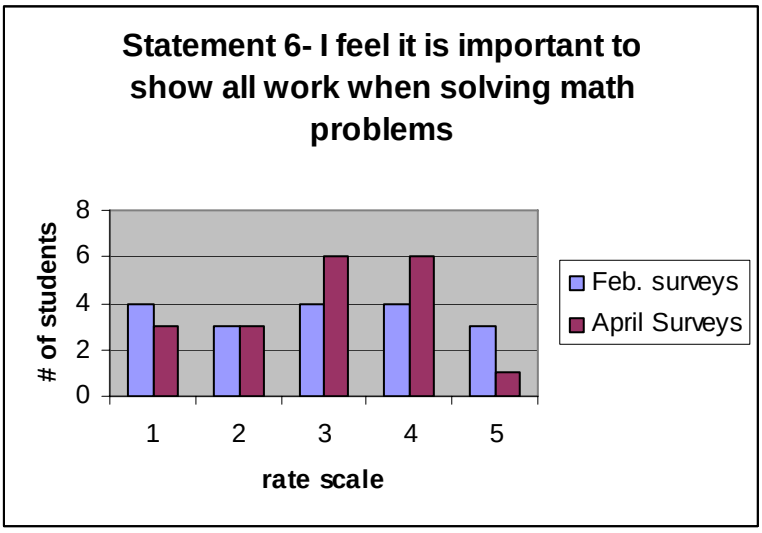
all the tests taken during this period. This tells me that a possible reason scores went down during the middle of the research is that students were getting used to what was now expected of them. It was something new they had to get used to and, once they did, their grades started to improve again.



I also chose seven students where I thought three students (Kim, Ella, and Sophie) did a great job on showing their work the majority of the time. Then I chose two students (Nate and Evan) who I did not believe showed their work as well as I would like them too and then I chose two students (Josh and Kenzie) who sometimes did and sometimes did not show their work. I wanted to look at a range of my students to see if I could notice patterns between students who did show their work and those that chose not to. I wanted to see if I would see improvement in the students who chose not to show work and see if the students who did show their work maintained showing their work throughout this period. I collected a few samples of their work before I started my new grading system and then I collected their work about once a week while I was grading my new way. If I look at the before homework and then the last homework I collected, I see a huge improvement of work being shown across the work of all seven students.

There is not work shown on every single problem but at least there is work shown for 75% of the problems they were asked to do compared to only a fourth or a half shown on the assignments collected at the beginning. (See two examples of these seven students' work in Appendix F.)

Now recall my last research question was, how do I get students to see the importance of showing their work? My assertion is that the more students understand, the more confidence they will have to do mathematics. I first looked at one of the survey statements where they had to rate how well they agreed with the statement. Results shows two more students rated this statement a three or a four in the April survey compared to the February survey. However, two fewer people rated it a five in the April survey compared to the February survey. This tells me more students feel showing work is important but a couple of students now think it is not quite as important as what they first thought.



I also looked at two of the open-ended survey questions. One was about why students felt showing work was important and the other one was about why they think their teacher feels showing work is important. I came up with these results.

On the February survey, when students were asked about why they felt showing work is important, about two thirds said it would help you check your work and see what you did right or

wrong. On the April survey, half of the students said it could help you get the right answer or check where you made mistakes. The students' opinions did not change much between the two surveys. If they thought it was important at the beginning of the research, they still felt it was important by the end of the research. On the other hand, if they did not feel showing work was important in February, they had the same feelings in April. Even though the students felt this way, it did not always come across in their work. Some students improved their grades by showing work but other students did not.

On the February survey, when students were asked about why their teacher feels it is important to show your work, about half said you will understand it better and get better grades and about a third said so she knows how I got my answer. On the April survey, about a third said she knows where we got the answer, another third said so you can get a better grade.

I then looked at an interview question I asked the seven students. "Do you think it is important to show your work/steps?"

	Feb. Interview	April Interview
Bailey	Sort of, if it is easy not necessary	sometimes
Erik	Yes, so you can check it over	Yes, so teacher knows how I got the answer and check your work
Cory	No, cause it gives me bad grades (doesn't know why it gives him bad grades)	No, once in awhile on hard problems
Annie	Yes, you don't get lost like you can when you do it in your head	yes
Darla	Sometimes on some problems	yes
Kenzie	Once in awhile on +, -. X, / or fractions it's important	yes
Matt	Yes, so you know if you have it right	Yes, you can check work and get better grades

As one can see, their answers did not change much between the February and April interviews. Six out of the seven agree it is important to show their work, so you can check it over and get a better grade. This tells me they know showing work is important but them saying it does not tell me whether they really do show their work on assignments.

I wrote a journal entry on February 27, 2007 about one of my students who asked for some help on a certain problem. I asked her if she showed her work and for the most part, she said she did. Then I asked her if she uses her work to check if the answer is correct or if the answer makes sense and she got a little red and said not all the time. This got me thinking about how I need to reiterate to my class that once you have shown your work, you can use it to see if your answers are correct. If they get into the habit of doing this, then both they and I will see their grades improve and they will have a greater understanding of the problem. Even though not all of their grades improved as much as I was anticipating they would, I do believe the students are starting to grasp the importance of showing their work.

I had students write a journal entry about what they have gained or learned from my research and their responses sum up what I was hoping to see through this experience. Ten of them wrote about how they learned showing their work was important, they will need to do it in high school, and it could help them get better grades. I think Darla's response is a good representation of what these 10 students were saying in their journals. "I have learned it is important to show my work. I have gained more knowledge for high school and the years beyond. I have also learned that when one shows work it helps one think through the whole problems." Kenzie wrote, "I've learned that know (typed as written) matter what you have to show your work. I will get a bad grade if you do not show your work. Also, it takes longer but…..it's worth it though. Show all steps you do" (4-25-07). I was excited to read these journal

responses. About half of my class learned showing work is important and you can benefit from doing so. I wanted my students to see why I ask them to show their work and I believe half of my students understand why now.

Conclusions

My findings tell me and other teachers who have the same frustrations and concerns students can see the importance of showing their work if they know how to show their work in a proper way. Students also need to know how to use their own work and check over it to make sure their answer is correct and makes sense. Teachers need to teach students how to show their work and use their work instead of just expecting them to do it on their own.

One can encourage students all they want to show their work but if one does not have some sort of reward or consequence, they might not do it. That is what I learned with my 6th grade class. I could preach and preach about the importance and the benefit of showing their work but if I did not grade them for it or give them some sort of reward, they do it how they want to and usually that was as fast as they could with as little of work as possible.

Another thing I found through doing this research is once students got used to showing their work, it became more of a habit for them instead of a chore. I still heard complaining but at least they were doing what was asked of them. I believe if teachers start the year with letting students know the importance of showing their work and showing them different ways of doing it, students will come to realize on their own, showing work is important. Students will start to see their grades improve and they will have a better understanding of what the assignment is asking them to do.

I believe my research goes along well with the scholarly literature I discussed earlier. Many authors talked about the importance of written communication and how it benefits the

student. Star (2002) says, “Current work lacks an emphasis on doing mathematics – in other words, using and understanding the mathematical procedures and skills that are an essential part of our discipline” (p. 2). I believe my research is helping students use and understand the mathematical procedures. I want them to show me their work so I can understand and see where they are coming from when they get a problem right or wrong. It will also help the student understand and have a deeper connection with a problem or assignment they are being asked to do if they show their work.

I did not find a lot of literature, however, on how grades could improve by students showing their work and this is where some of my research comes in. Even though one does not see big differences when it comes to grades improving, I did see some of my students increase their scores. As I said before, I believe if I would have started this at the beginning of the year and really told the students what I expected from them then, I would have seen a bigger improvement in their homework grades. My study was done in a short amount of time, which did not let me see dramatic changes in student learning based on grades. Maybe this is a reason why I did not see a lot of literature on this particular subject in that it takes a long time for students to get in the habit and really know what they are doing when it comes to showing the proper kind of work. I believe if I would have started this research in my 4th grade class and did it over the three years I worked with them, I would see a significant difference in their grades from fourth to sixth grade.

Implications

Because of my study, I plan to really teach and preach the importance of showing work at the beginning of the year and continue throughout the year. I want my students to be able to show their work and understand what they are doing. I want them to be able to explain their

work or their thinking process to someone else. I want my students to feel confident in what they are doing and be prepared to go into 7th grade.

I also plan to start all of this with my 4th grade class and continue to do it every year in hopes of seeing improvements not only with their grades but also with their confidence in math as well. I am going to show them the right and wrong ways to show work. I want them to feel comfortable and get into a habit of showing their work whether they consider it easy or not.

Another thing I plan to do is have all of my classes write journals more often. I believe I learned some valuable things regarding what students were thinking when it came to math class and their ideas about math and math homework. I received some good insight into what they were thinking that they might not want to tell me in person or in front of the class. I would also like to keep giving surveys about the students' general feelings about mathematics and showing work at the beginning and end of the year. This will help me see what I can improve on when it comes to my teaching and see what the students' feelings are at the start the school year compared to the end of the school year. I will also keep journaling and reflecting on my teaching and what I am seeing in my classroom to better myself as a person and a teacher. I will be able to reflect on my teaching and how I handle different things in my classroom and I can improve or change the things I am doing to better help my students. I can sit back and look to see if what I am doing is the best for my students or if I can improve my teaching in some way.

One last thing I plan on doing is talk with other mathematics teachers in my building and in my district and show them the findings from my research. If lower elementary teachers can start talking about showing work and how it is important for students to be able to write what they are thinking then maybe when I get students in 4th, 5th, or 6th grade, they will have an understanding of what I am asking of them. Then it will not be as big of a shock to their system

that they might have to take a little more time on their homework. In the end, it will likely make them a better math student. It is also paving the way for me to move from teaching students how to show steps to teaching students how to explain the reasoning or the why behind their work.

References

Blando, J. A., Kelly, A. E., Schneider, B. R., & Sleeman, D. (1989). Analyzing and modeling arithmetic errors. *Journal for Research in Mathematics Education, 20*(3), 301-308.

Clements, M. A. (1982). Careless errors made by sixth-grade children on written mathematical tasks. *Journal for Research in Mathematics Education, 13*(2), 136-144.

Evens, H. & Houssart, J. (2004). Categorizing pupils' written answers to a mathematics test question: 'I know but I can't explain'. *Educational Research, 46*(3), 269-282. Retrieved November 12, 2006, from Routledge Taylor & Francis Group database: http://journalsonline.tandf.co.uk/

Kloosterman, P., Raymond, A. M., & Emenaker, C. (1996). Students' beliefs about mathematics: a three-year study. *The Elementary School Journal, 97*(1), 39-56.

Krebs, A. S. (2005). Analyzing student work as a professional development activity. *School Science & Mathematics, 105*(8), 402-411.

Moskal, B. M. & Magone, M. E. (2000). Making sense of what students know: Examining the referents, relationships and modes students displayed in response to a decimal task. *Educational Studies in Mathematics, 43*(3), 313-335.

Neria, D. & Amit, M. (2004). *Students preference of non-algebraic representations in mathematical communication* (Rep.-Evaluative No. 142). Negev, Israel: Ben-Gurion University. (ERIC Document Reproduction Service No. 489599).

Star, J. R. (2002). *Re-"conceptualizing" procedural knowledge in mathematics*. (Rep.-Descriptive No. 141). University of Michigan: Author. (ERIC Document Reproduction Service No. 472 948)

Watson, I. (1980). Investigating errors of beginning mathematicians. *Educational Studies in Mathematics, 11*(3), 319-329.

Appendix A

Pre and Post 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
I show my work/steps for every problem that I can	1 2 3 4 5
3. Math skills are important for other skills.	1 2 3 4 5
4. I am able to show the work required to solve math problems.	1 2 3 4 5
5. I feel it is important to show all of work when solving math problems	1 2 3 4 5
6. My grades improve when I show my work/steps.	1 2 3 4 5

COMPLETE THE FOLLOWING STATEMENTS .

7. This is my favorite math concept and why:

8. One good thing that happened in math is:

9. One not so good thing that happened in math is:

10. What I wish my math teacher knew about me is:

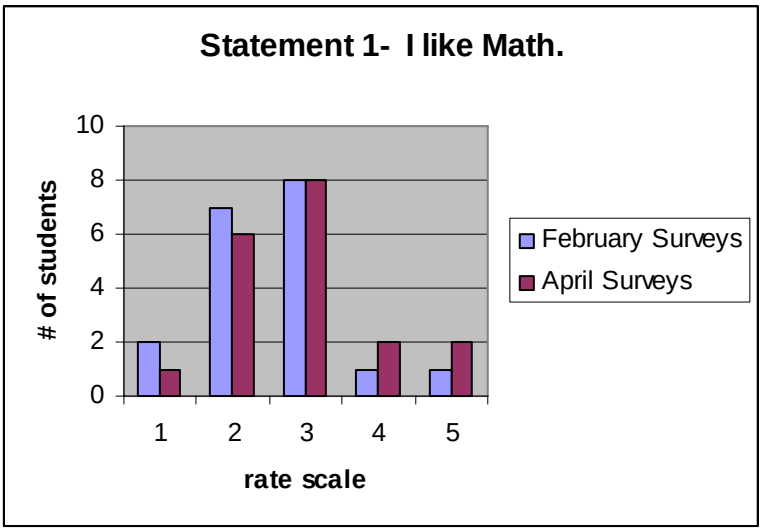
11. I feel that showing your work is important because…..

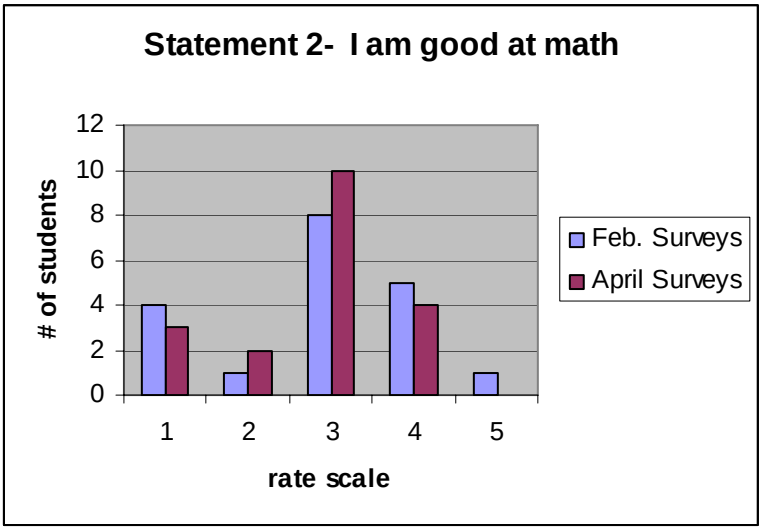
12. My teacher feels it is important to show your work because……

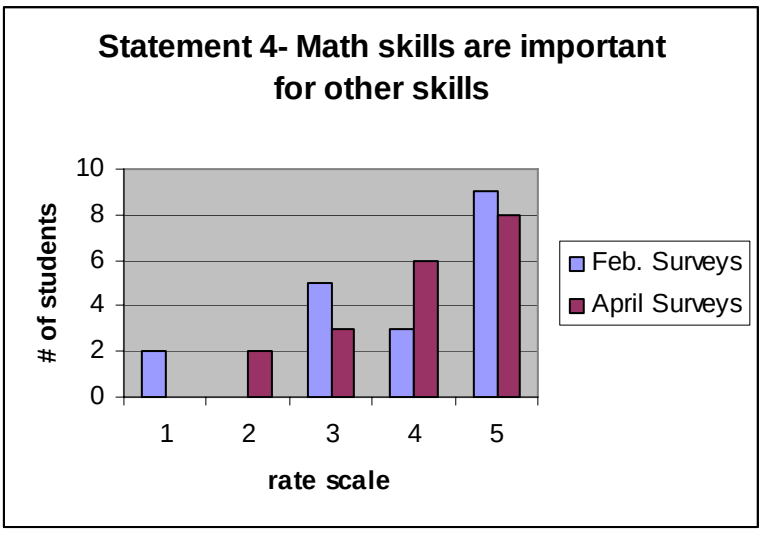
13. Is there a time when you should not have to show your work and if so when?

14. I do not like to show my work because……

Appendix B
(the rest of the graphs are included in the paper)







Appendix C

Student interview questions

1. How do you like math this year?
2. How much time on average do you spend on homework assignments?
3. What do you think is the purpose of math homework?
4. What does it look like when you justify your answers on a homework assignment?
5. What are the benefits of justifying your answers on your homework assignments, if any?
6. I would like you to work on this problem, saying aloud whatever it is you are thinking as you work through the problem. I especially want to hear you talk about how you decide what to do to solve the problem.

i. Emma is saving money to buy a bike that costs $72. She wants to buy the bike after saving the same amount of money each week for 6 weeks. How much money does she need to save each week?

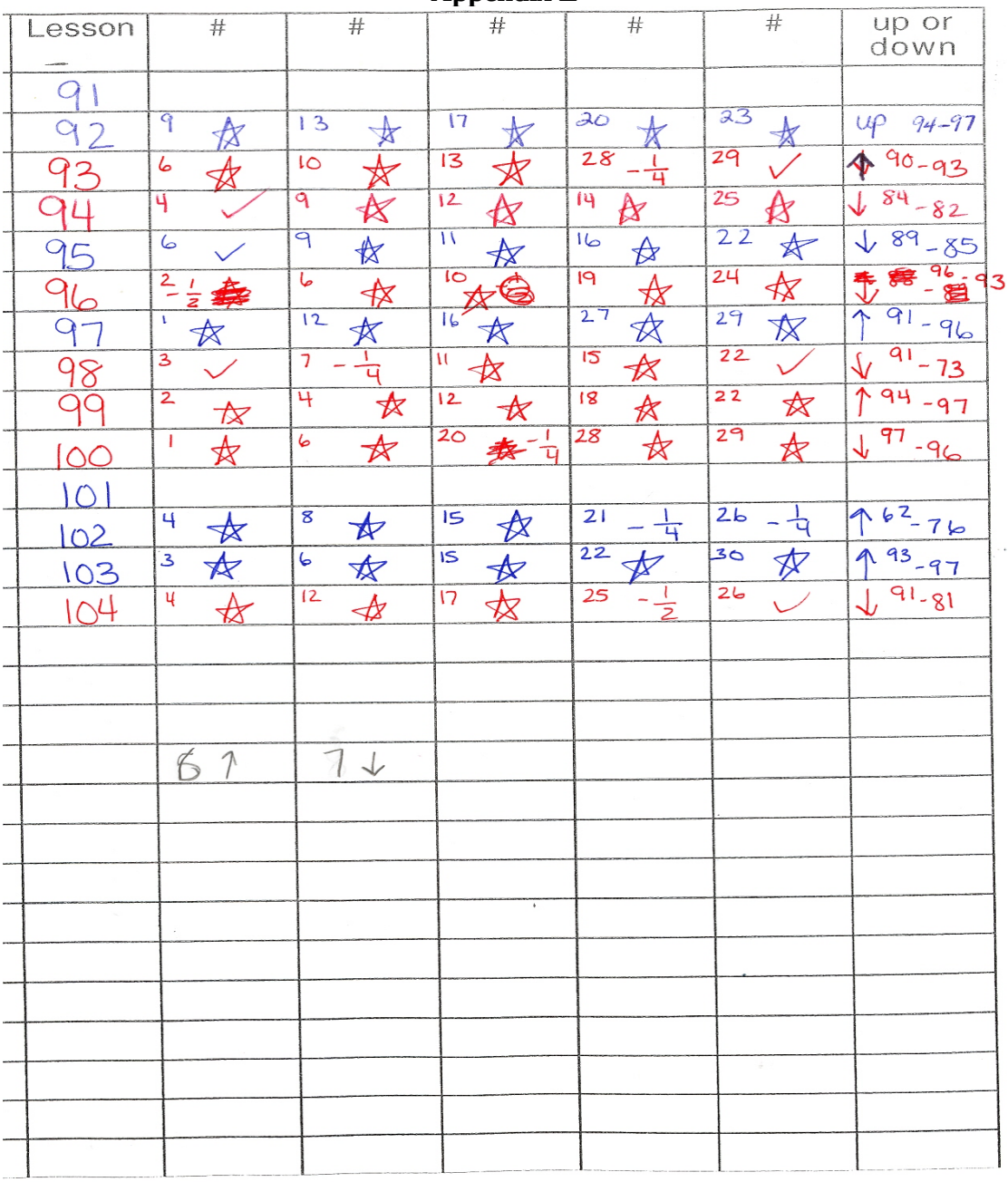
7. Is there anything you want to know from me?
8. Is there anything else I should know about you to better understand your problem solving in math or your general math experience?
9. What do you think about when your teacher asks you to show your work/steps?
10. Do you think it is important to show your work/steps?
11. When do you think it is ok not to show your work?
12. Why do you think there are some students who can't do very well in math?

Appendix D

Journal prompts for the students

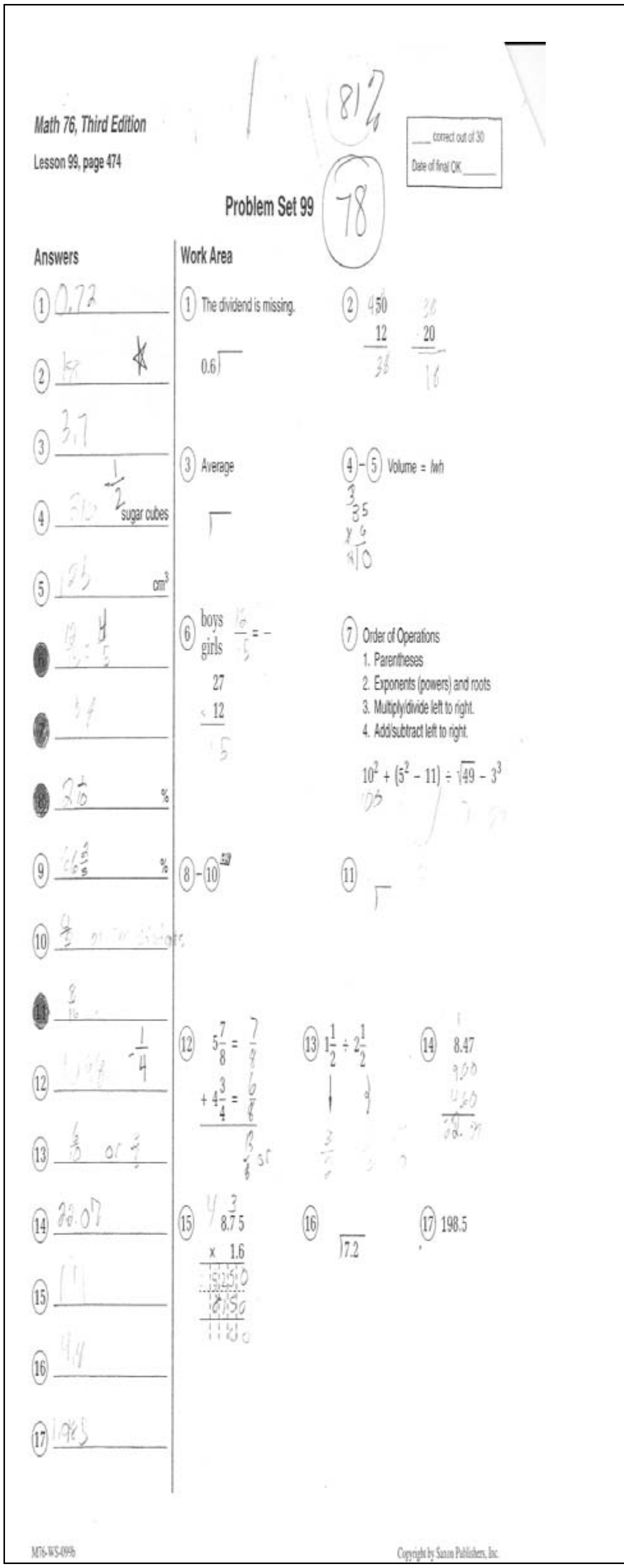
1. Describe and give examples of how you showed your work
2. How do you feel about how well you are doing in math class?
3. What can you do to make fewer mistakes in math?
4. Why should you check your work?
5. What are your impressions on the new way of grading your homework?
6. What have you gained or learned from Miss Kelly's research?

Appendix E



Lesson	#	#	#	#	#	up or down
91						
92	9 ☆	13 ☆	17 ☆	20 ☆	23 ☆	up 94-97
93	6 ☆	10 ☆	13 ☆	28 -1/4	29 ✓	90-93
94	4 ✓	9 ☆	12 ☆	14 ☆	25 ☆	84-82
95	6 ✓	9 ☆	11 ☆	16 ☆	22 ☆	89-85
96	2-1/2 ☆	6 ☆	10 ☆	19 ☆	24 ☆	96-93
97	1 ☆	12 ☆	16 ☆	27 ☆	29 ☆	91-96
98	3 ✓	7 -1/4	11 ☆	15 ☆	22 ✓	91-73
99	2 ☆	4 ☆	12 ☆	18 ☆	22 ☆	94-97
100	1 ☆	6 ☆	20 -1/4	28 ☆	29 ☆	97-96
101						
102	4 ☆	8 ☆	15 ☆	21 -1/4	26 -1/4	62-76
103	3 ☆	6 ☆	15 ☆	22 ☆	30 ☆	93-97
104	4 ☆	12 ☆	17 ☆	25 -1/2	26 ✓	91-81
	6↑	7↓				

Appendix F



Math 76, Third Edition

Lesson 99, page 474

___ correct out of 30

Date of final OK ______

Problem Set 99

Answers

Work Area

(1) The dividend is missing.

(3) Average

(4)–(5) Volume = lwh

(6) boys / girls

(7) Order of Operations
1. Parentheses
2. Exponents (powers) and roots
3. Multiply/divide left to right.
4. Add/subtract left to right.

$10^2 + (5^2 - 11) \div \sqrt{49} - 3^3$

(12) $5\frac{7}{8}$ $+ 4\frac{3}{4}$

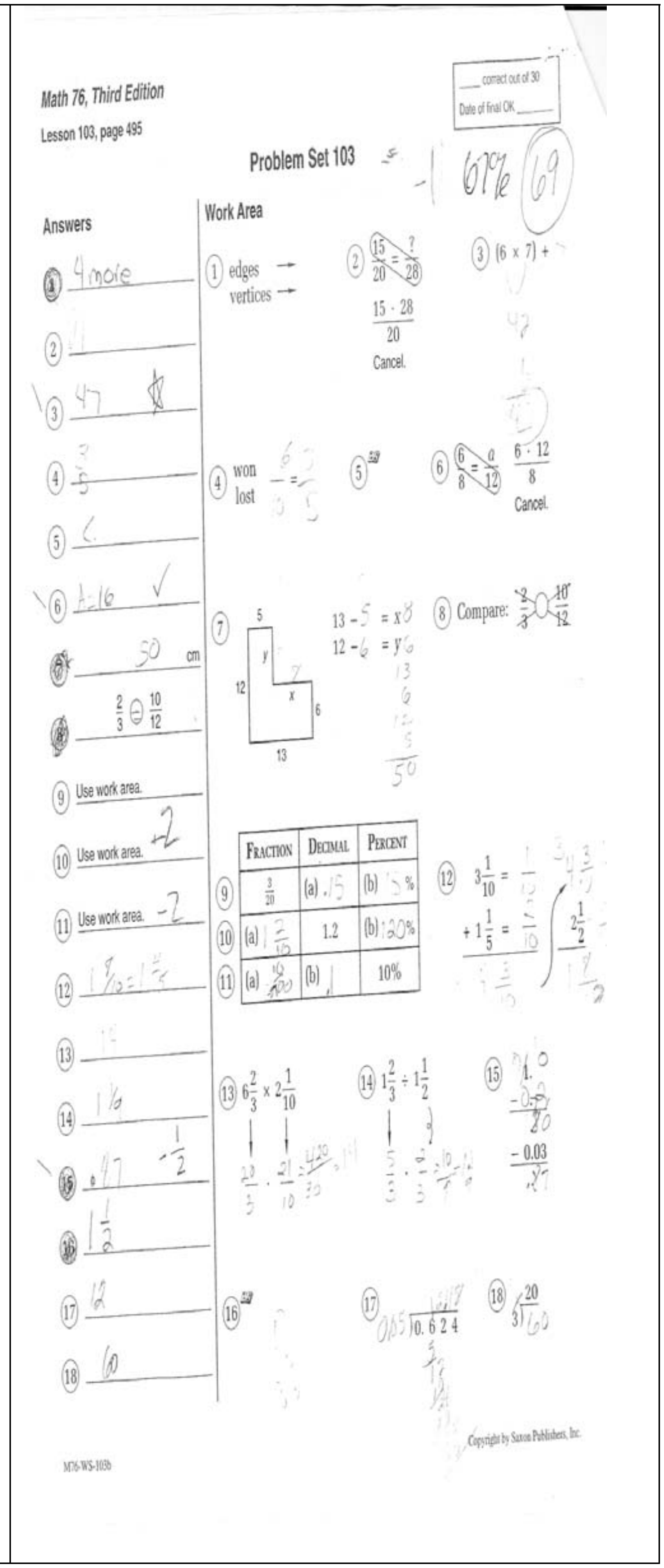
(13) $1\frac{1}{2} \div 2\frac{1}{2}$

(14) 8.47

(15) 8.75 × 1.6

(17) 198.5

M76-WS-099b



Math 76, Third Edition

Lesson 103, page 495

___ correct out of 30

Date of final OK ______

Problem Set 103

Answers

Work Area

(1) edges → vertices →

(2) $\frac{15}{20} = \frac{?}{28}$ $\frac{15 \cdot 28}{20}$ Cancel.

(3) (6 × 7) +

(4) won / lost

(6) $\frac{6}{8} = \frac{a}{12}$ $\frac{6 \cdot 12}{8}$ Cancel.

(8) Compare: $\frac{2}{3} \bigcirc \frac{10}{12}$

(9) Use work area.

(10) Use work area.

(11) Use work area.

	Fraction	Decimal	Percent
(9)	$\frac{3}{20}$	(a)	(b) %
(10)	(a)	1.2	(b)
(11)	(a)	(b)	10%

(12) $3\frac{1}{10}$ $+ 1\frac{1}{5}$

(13) $6\frac{2}{3} \times 2\frac{1}{10}$

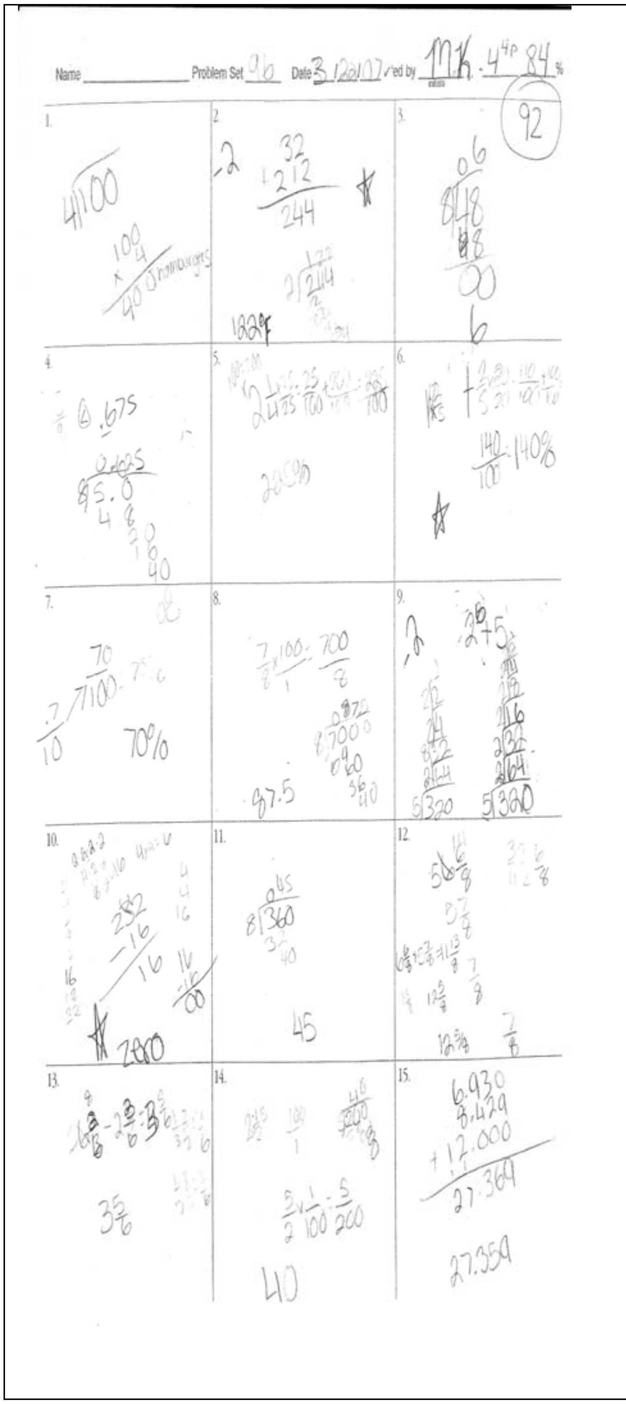
(14) $1\frac{2}{3} \div 1\frac{1}{2}$

(15) 1. − 0.03

(17) 0.6 2 4

(18) $3\overline{)60}$

M76-WS-103b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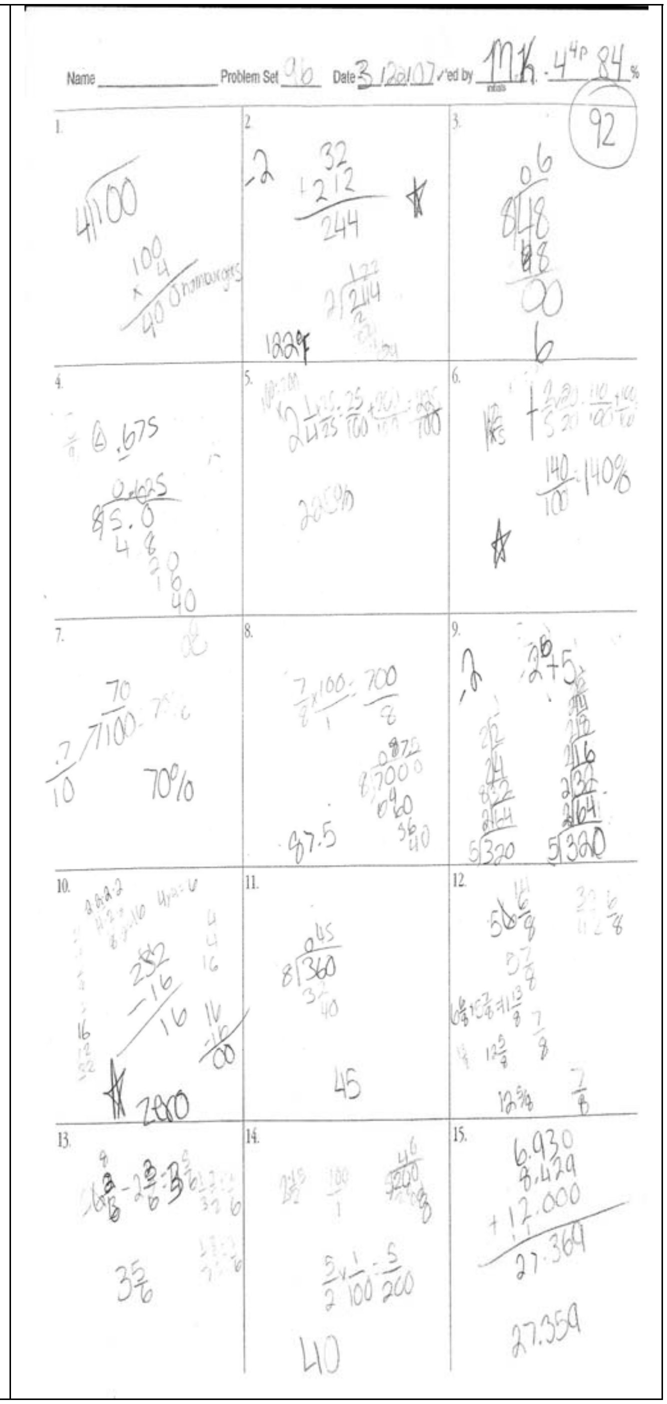
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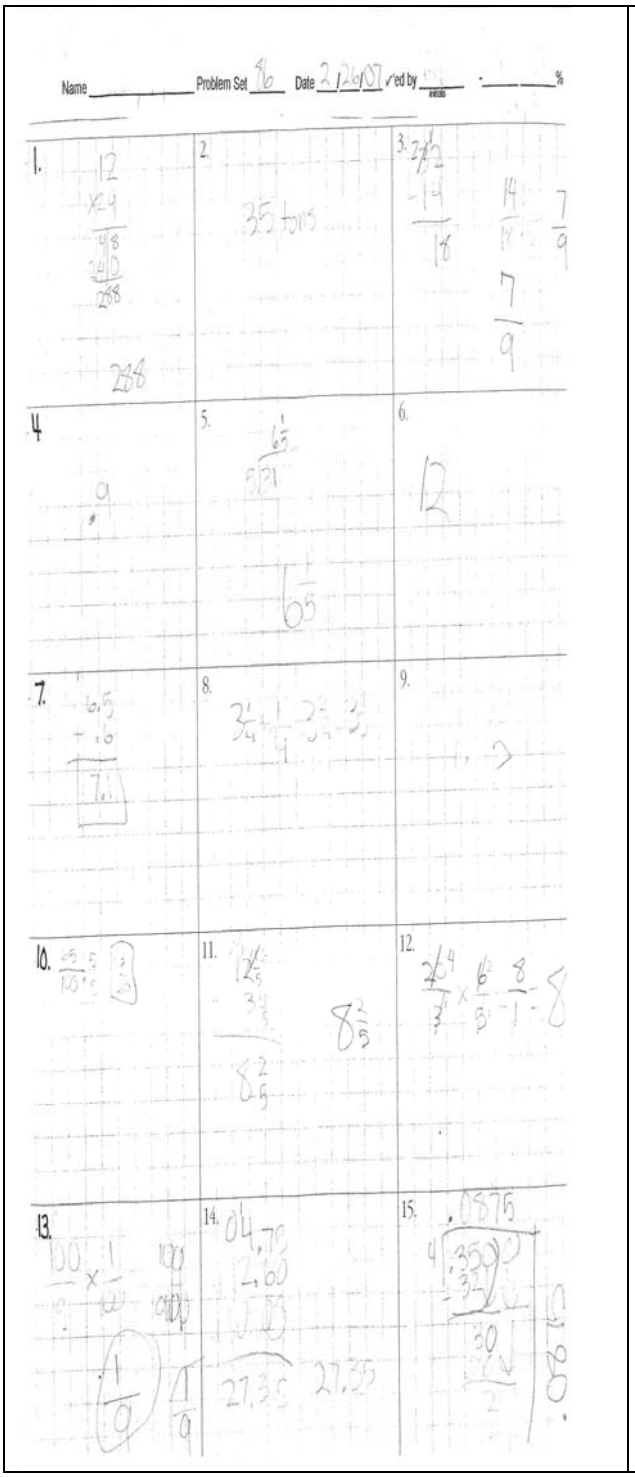
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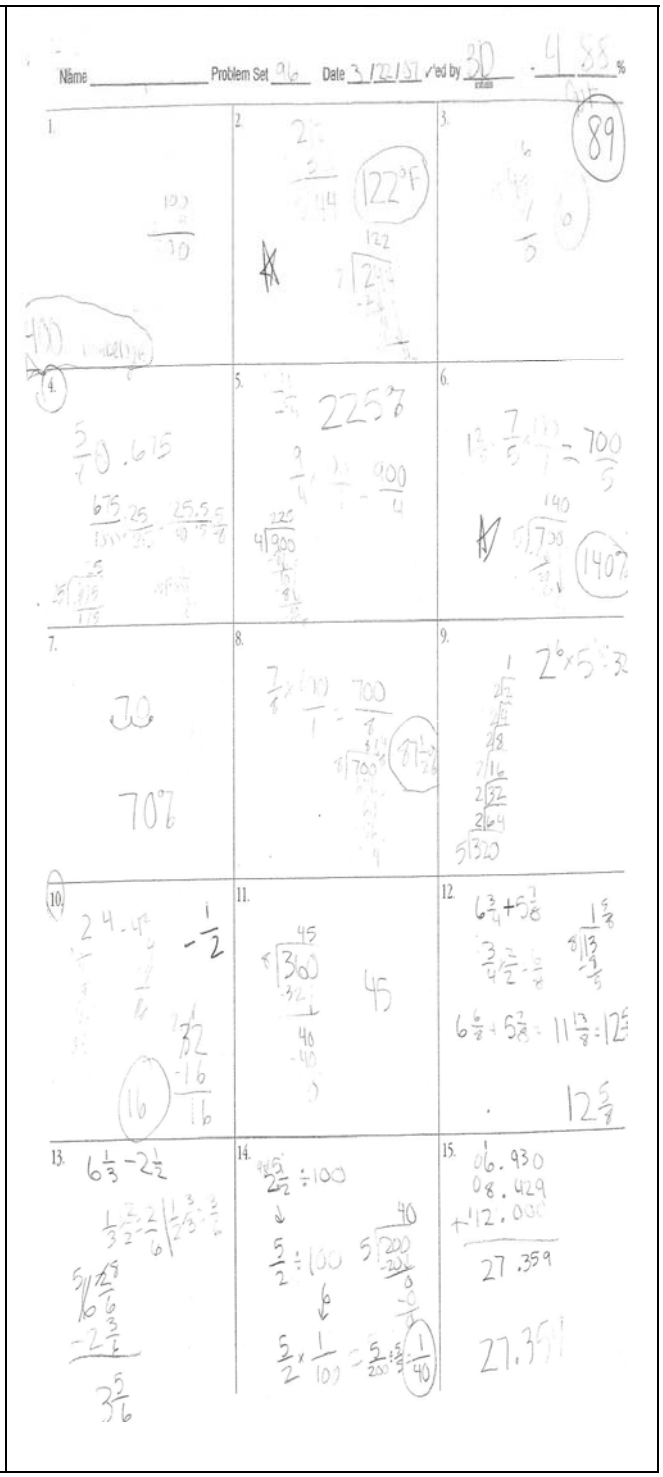
14.
15.


Name
Problem Set 96
Date 3/12/15
ved by
1.
2.
122°F
3.
89
4.
5.
6.
140
140%
7.
30
70%
8.
9.
10.
11.
45
12.
13.
14.
15.
27.359
27.359

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___ correct out of 30

Date of final OK _____

Problem Set 97

Answers

1. $\frac{3}{4}$
2. 32 in.
3. 160
4. 27 cm
5. Use work area.
6. ____ in.
7. C
8. 21
9. 10 %
10. $233\frac{1}{3}$ %
11. $7.50
12. 333 ✓
13. $\frac{1}{3}$
14. .02

Work Area

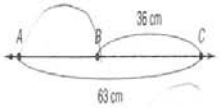
1. $\left(\frac{1}{4} + \frac{3}{4}\right) \div \left(\frac{1}{4} \times \frac{3}{4}\right)$

2. (5 x ____) + 6 in.

   ft = ? in.

3. $\frac{4}{5}$ of 200 finished

   $\frac{1}{5}$ of 200 did not

4. 

5. 25,000

   (__ x 10,000) + (__ x __)

6. -7

8. As this sequence continues, each number equals the *sum of the two prior numbers*. What is the next number in this sequence?

   1, 1, 2, 3, 5, 8, 13, 21, ...

9. -10

11. $\overline{)\$0.60}$

12. $\overline{)0.03}$ $-\ 0.001$

13. $\frac{10}{3} \times \frac{100}{1}$

14.

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___ correct out of 30

Date of final OK _____

Problem Set 96

Answers

1. 400 hamburgers
2. $\frac{1}{2}$ 117 °F
3. 6
4. $\frac{5}{8}$ ◯ 0.675
5. 25 %
6. ★ 140 %
7. 10 %
8. 87½ %
9. ★ 2.5
10. 0
11. 35
12. 25
13. $\frac{25}{100}$
14. 150
15. 27359
16. 11
17. 1.075
18. $\frac{5}{6}$ ✓
19. 20 %

Work Area

1. hamburgers $\frac{4}{1}$ $\frac{?}{100}$

2. Halfway: Add; then divide by 2.

3. Average

4. Compare: $\frac{5}{8}$ ◯ 0.675

5. -7

8. $\overline{)700\%}$

9. 320 =

10. $2^4 \rightarrow$

    $4^2 \rightarrow$

11.

12. $6\frac{3}{4} =$

    $+ 5\frac{7}{8} =$

13. $6\frac{1}{3} =$

    $- 2\frac{1}{2} =$

14. $2\frac{1}{2} \div 100$

15. 6.9.3

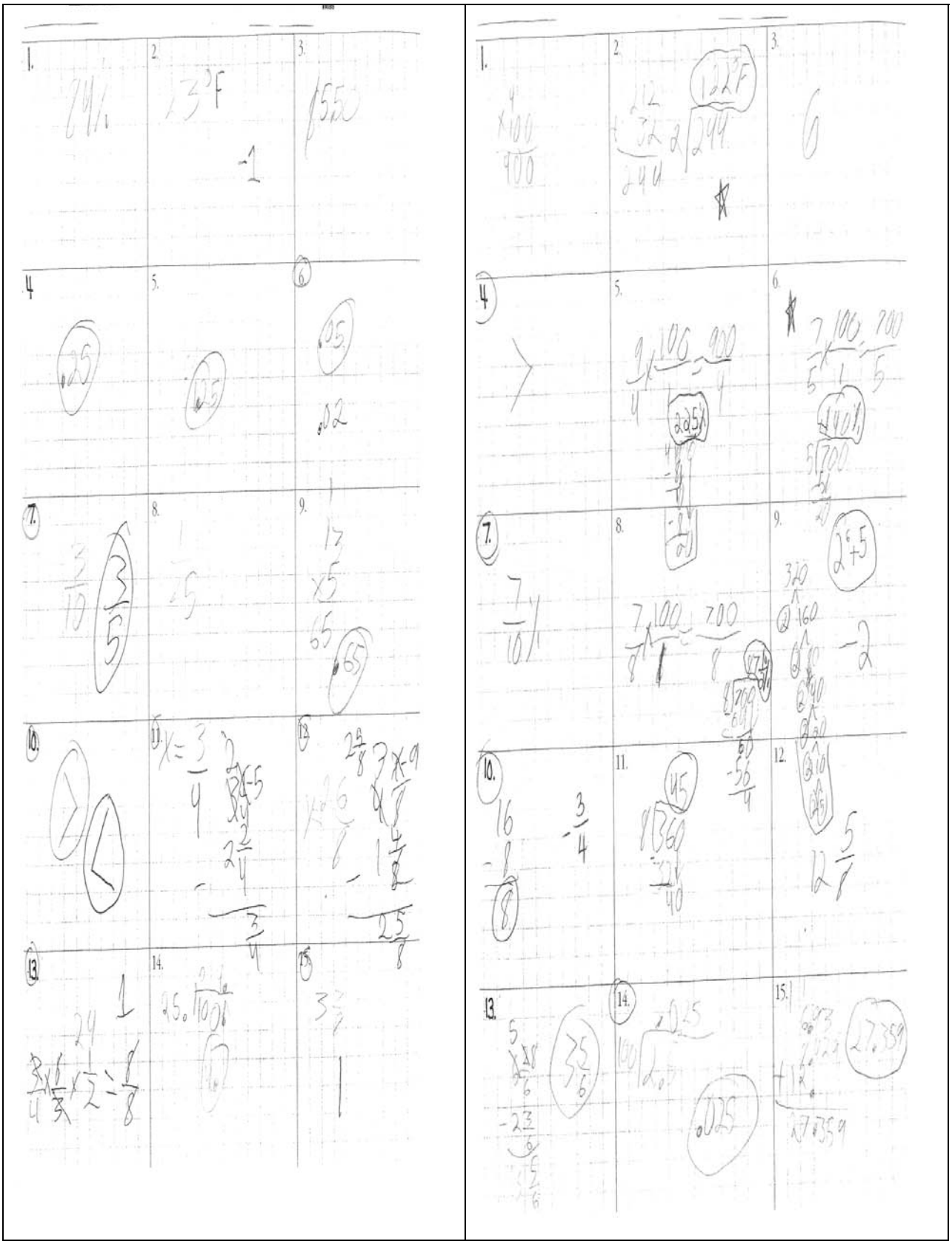
16. $\overline{)1.00}$ $-\ 0.1$

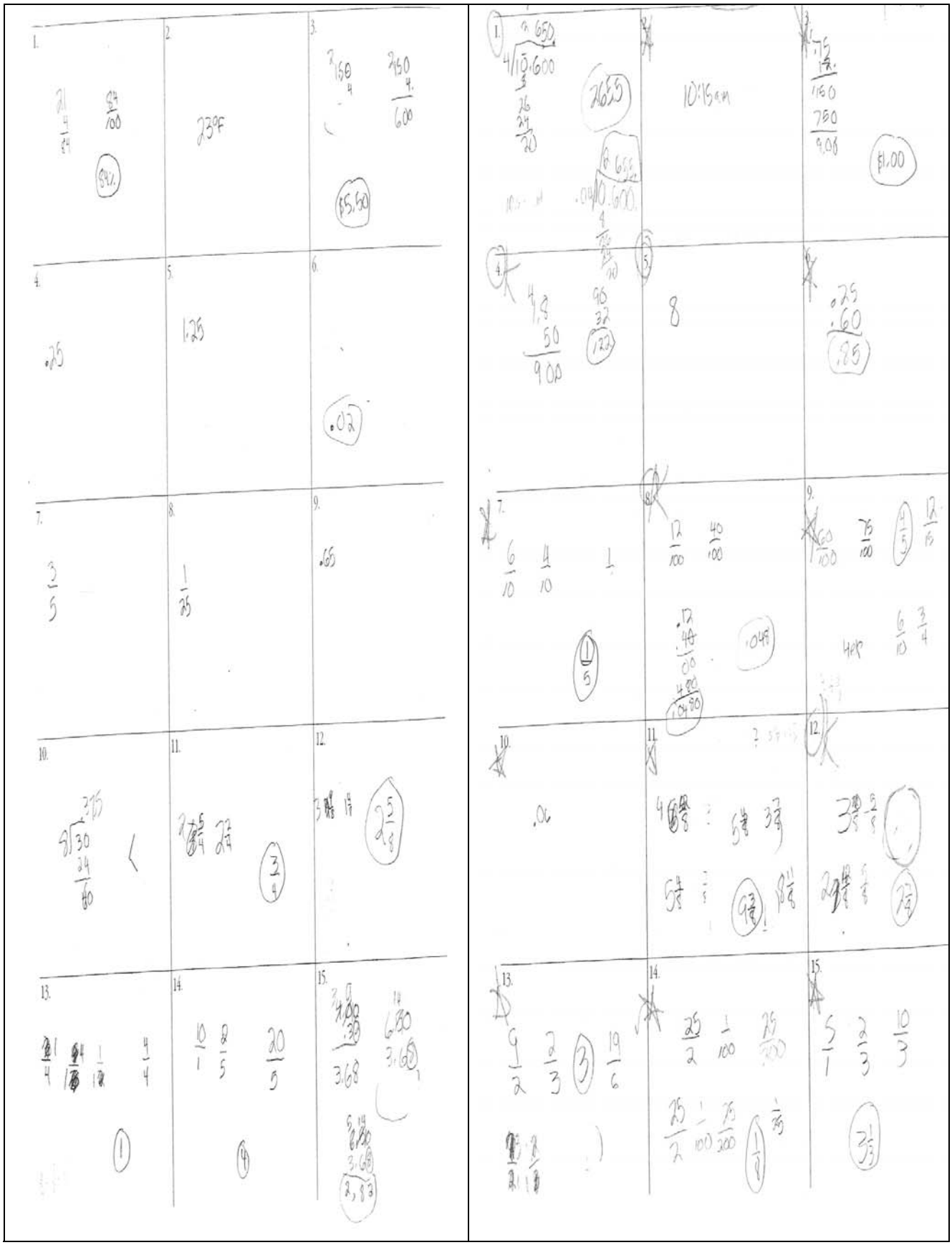
17. 4.2 0

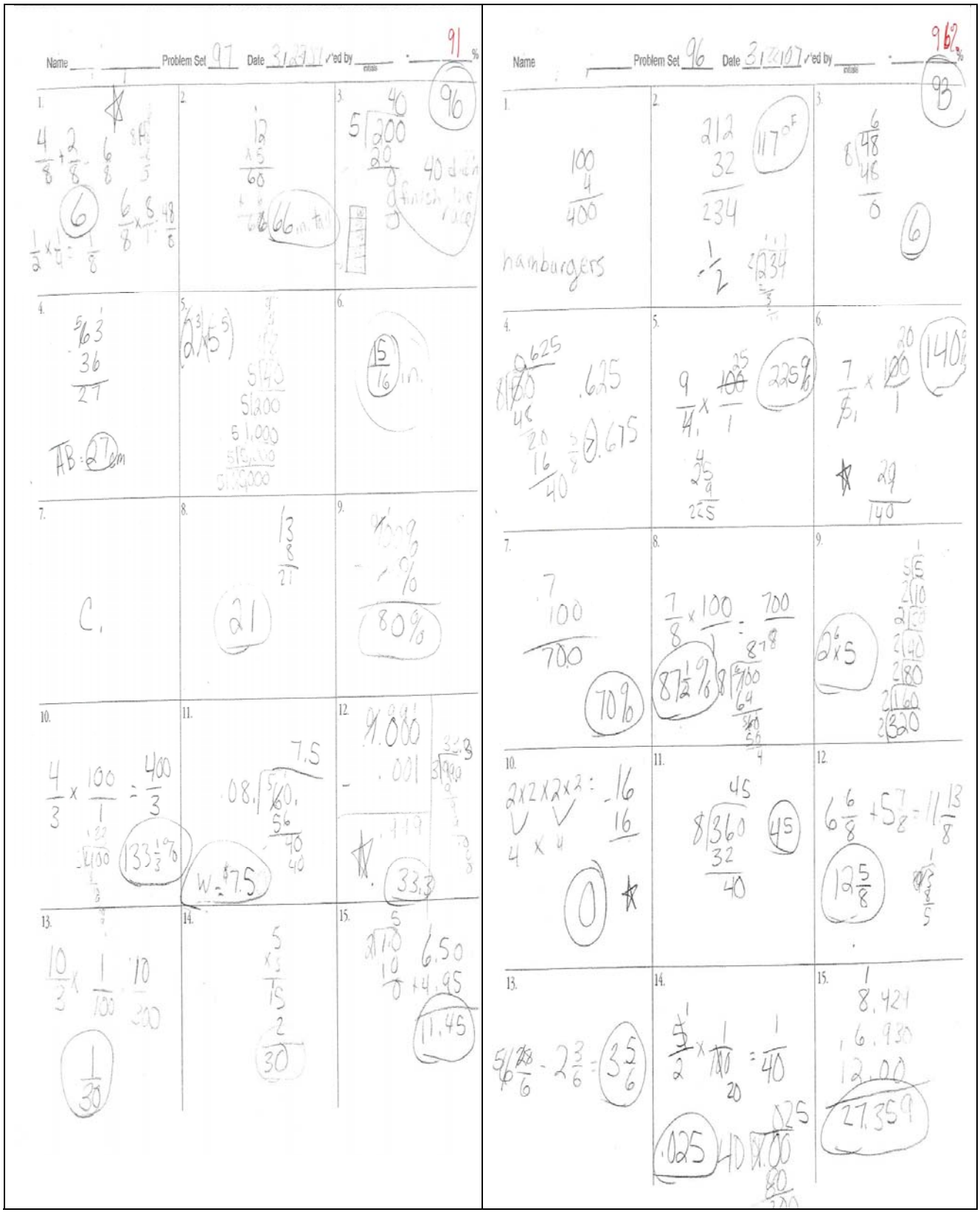
    $+\ .325$

18. $3\frac{1}{3} =$

19.






Name
Problem Set 97
Date 3/29/11
checked by
91 %
1.
2.
3.
96
4.
AB = 27 cm
5.
6.
15/16 in.
7.
C.
8.
21
9.
80%
10.
133 1/3 %
11.
W = $7.5
12.
33.3
13.
1/30
14.
30
15.
6.50
+4.95
11.45
Name
Problem Set 96
Date 3/29/11
checked by
96 %
1.
hamburgers
2.
117°F
3.
6
4.
.625
5.
225%
6.
140%
7.
70%
8.
87 1/2 %
9.
10 x 5
10.
0
11.
45
12.
13.
14.
.025
15.
27.359