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Daily Problem-Solving Warm-Ups: Harboring Mathematical Thinking In The Middle School Classroom

Diana French Alliance, Nebraska

A report on an action research project submitted in partial fulfillment of the requirements for participation in the Math in the Middle Institute.

University of Nebraska-Lincoln

Daily Problem-Solving Warm-Ups: Harboring Mathematical Thinking in the Middle School Classroom

Abstract

In this action research study of my classroom of 8th grade mathematics, I investigated the use of daily warm-ups written in problem-solving format. Data was collected to determine if use of such warm-ups would have an effect on students' abilities to problem solve, their overall attitudes regarding problem solving and whether such an activity could also enhance their readiness each day to learn new mathematics concepts. It was also my hope that this practice would have some positive impact on maximizing the amount of time I have with my students for math instruction. I discovered that daily exposure to problem-solving practices did impact the students' overall abilities and achievement (though sometimes not positively) and similarly the students' attitudes showed slight changes as well. It certainly seemed to improve their readiness for the day's lesson as class started in a more timely manner and students were more actively involved in learning mathematics (or perhaps working on mathematics) than other classes not involved in the research. As a result of this study, I plan to continue using daily warm-ups and problem-solving (perhaps on a less formal or regimented level) and continue gathering data to further determine if this methodology can be useful in improving students' overall mathematical skills, abilities and achievement.

As a participant in the Math in the Middle Institute Partnership designed to improve mathematics education at the middle school level, we were asked to perform an action research project with one of our classes. I teach middle school mathematics at Best Middle School. I've held this same position for 7 years and my assignments include three basic courses: 8th grade Pre-Algebra (5 sections), 7th grade Advanced Math (1 section) and 8th grade General Math (1 section.) I selected one class of 8th grade Pre-Algebra to focus my action research on since it was the most diverse grouping of students of any of my classes with respect to gender, race, overall ability, socio-economic status and ethnicity.

Our school is currently in the process of seeking accreditation through NCA and as a part of that process we have written specific school improvement plans. For the mathematics department, that plan is to improve students' problem-solving skills. With that being a major focus of instruction, I elected to base my action research project on some activity that would hopefully enhance the problem-solving instruction and help meet the goal of our improvement plan. By exposing the students to problem solving on a daily basis I also sought to improve some daily instructional practices and general classroom routines.

Since I was the chief investigator for this project and the students were already comfortable with me as their daily math teacher, my role as the researcher in their eyes did not impact their comfort level or behavior. I spent time explaining to the class what each of our roles would be in this process and how it would be a great opportunity for us to learn from each other. I built up the idea of this group being chosen and unique (we referred to the group as "The Problem Solvers") and they were (for the most part) excited to be a part of the project.

Problem of Practice

In looking at a *normal* routine in my daily mathematics classroom, a major concern about the amount of class time that is taken up by my current practices include:

- a) trying to meet our district-wide NCA goal of improving problem solving by giving more exposure to and practice with problem solving one class period per week;
- b) taking attendance while the students mill about and socialize and generally waste time; and
- c) convincing students to attempt problem-solving and improve their overall attitudes and perceptions of problem-solving in general.

Taking attendance generally only takes one or two minutes. I found that students, when left without direct, explicit instruction or guidance, will use that time as "free" time or time to socialize. Others see it as an opportunity to be tardy, since "we aren't really doing anything for those first few minutes anyway!" This seemed like a great deal of wasted time and opportunity, especially when you consider how much time that is over the span of one school year! I needed to find a way to utilize this time and help get my students in "math mode," ready to learn the new day's lesson when I was ready to teach it without having to "call them to order" and wait for them to get situated.

Our school's previous idea for offering more problem solving was to focus on strictly "problem solving" (strategies, practice, etc.) one day each week. In observing this, I found I was losing about 3-5 minutes each day of instructional time for attendance-taking and situating. I was also "losing" a day of introducing or building upon new concepts by spending 20% of my week "problem solving." I continually felt like I was playing "Beat the Clock!" on a daily basis. A rushed or hurried lesson cannot be the effective, meaningful lesson it should be. Rather than producing higher achieving students, the "bare bones" or "minimum required" seemed to be a common result in my classroom.

I originally saw my problem as being "too much time away from actual instruction and student interaction/involvement." As I began to observe my practices (with what is expected of me in mind), I

began to wonder if a culmination of events/activities could remedy one or more of the areas concerning me. As an ideal, I would like to see my classroom be one which is extremely efficient to maximize the amount of time I have to help my students learn as much mathematics as possible.

As a major focus of "as much mathematics as possible," I want to see my students show a willingness to tackle problem solving situations with a more open mind, using a variety of strategies effectively, and a willingness to do so without me having to lead them by hand through the process, "get them started" and/or persuade them to attempt a problem before seeking my assistance. This pertains to my personal and "local" goal and practice improvement within my classroom.

Additionally, I want to be fair in my grading by using a sampling of all work the students do in my assessment of their learning. I want to reward and acknowledge students for the work they do while emphasizing the need for and importance of it without it taking away from time I could be moving them further along in their mathematics journey. I believe these areas indicate an ideal that relate more to the community of teachers within my district/school.

As an aside to this, I want to set an example for them that regimented, organized and planned use of time is beneficial and practical, efficient and effective. If I am able to "seize the moment," perhaps they will, too! I believe a more structured (and math-oriented) start-up routine can help accomplish many of those things. My action research will help answer these questions for myself and hopefully lend a strategy to others who struggle with these issues as well. This could help our district teachers as well with our common NCA goal relating to problem solving and a possible technique enabling us to meet that goal.

As a teaching strategy or practice, I do not recall ever having a teacher use "daily warm-ups," nor was I exposed to it by my supervising teachers during my student teaching experiences. That's not to say I wasn't ever aware of daily warm-ups or never considered using them. I simply didn't ever see them as a solution to other problems. Rather, I saw them more as "one more thing to cram into

an already full class time schedule." In rethinking this stance, I believe this may do just the opposite. If a daily warm-up can actually replace (effectively and efficiently) one or two of the events that are already "crammed" in, perhaps I can share this knowledge and inspire others to make changes as well.

As teachers are asked to accomplish more and more, often with the same amount of preparation time, training and funding, finding ways to become more efficient and better manage time is imperative. While this small amount of time saved (if, indeed, it does prove to increase instructional time) may be only the beginning of accomplishing that, every minute is precious and valuable to an educator trying to accomplish "more." Ultimately, if more time is spent on instruction and learning, students will become more successful mathematically, achieve more and be that much further along in acquiring the necessary skills and mathematical knowledge sought, required or desired. This, I believe, is paramount to all mathematics educators.

On a final note, as "problem solving" is central to the NCTM standards (in fact, it is central to what mathematics education is <u>supposed</u> to be about), the larger community of educators can benefit from the knowledge obtained in this research. Perhaps problem solving as a daily warm-up will prove to be an effective strategy that improves problem solving across the board. As an educator, these are areas in which I would find more information and ideas to be beneficial and worth knowing.

Literature Review

With the current focus of mathematics being on problem solving, there is much research regarding various approaches, beliefs and interventions. With an idea of implementing daily warm-ups in problem-solving form, however, there is little or no research available from which to compare, contrast or glean information. Likewise, research and information regarding these warm-ups as a means of effective time management was also difficult to find.

With a belief that all students need to be mathematically proficient and capable of solving math-related problems they encounter in daily life, studies of students' performance show a general lack in their abilities and proficiency with problem-solving skills. The National Research Council (NRC, 1999) warned that mathematics skills of American children are woefully inadequate for the kinds of problem solving required in the workplace. Supported by the 1992 results of the National Assessment of Educational Progress (NAEP), which shows about 59% of 12th-grade students could solve problems beyond whole-number computation, there seems to be just cause for the focus of mathematics education to be making the shift to that of problem solving.

The shortcomings in adequately providing problem solving skills and abilities to students may stem from the failure of teachers to generalize problem-solving skills which may, in turn, have been "exacerbated by researchers and educators who have inadvertently stifled student interest by smoothing out the curriculum into computational and simplistic formats, thereby limiting students' autonomous learning capabilities" (Bottge, 1999, p. 82). In essence, the focus on algorithms and facts seems to take precedence in many classrooms leaving a lack of educational opportunities to harbor higher-level thinking and problem solving applications to the mathematics learned.

Much of student attitude regarding problem solving and mathematics is a direct reflection of that of the teacher's attitude and willingness to incorporate problem solving as a major part of mathematics instruction. James A. Middleton (1995), in a research project regarding intrinsic motivation in the mathematics classroom, found teachers generally ill-equipped and unable to predict or utilize current student attitudes to help students turn the corner on improving their mathematics and problem solving attitudes. "The lack of knowledge regarding motivation was also manifest in teachers' attention to the utility and importance of mathematics for students' future lives." (Middleton, 1995, p. 275). Similarly, the motivation necessary to bring about and maintain deliberative processing is also evidenced in the use of problem solving units according to a 2004 study of problem solving in middle school

mathematics (Leader & Middleton, 2004). In general, research resoundingly emphasizes how increased and improved problem solving skills directly affect student attitude, and vice versa (Bottge, 1999; Hiebert, 1996; Higgins, 1997; Leader & Middleton, 2004; Middleton, 1995; Pape, 2003; Resnick, 1989; Schoenfeld, 1989).

Overall, mathematics achievement and success also seems to be heavily related to the area of problem solving. A study by Pape (2002) utilized different approaches and strategies to boost student achievement. His findings, coupled with subsequent analyses of other researchers, seem to implicate an improvement in student self-regulation as well. The link between attitude, success with problem solving, and student independence to take on more rigorous problem solving appears in many research articles (Leader, Middleton, 2004; Pape, 2002; Resnick, 1989; & Schoenfeld, 1989). However, there seems to be a more prevalent connection to attitude and improved skills with problem solving with overall mathematical achievement. The consensus of the research points to exposure to problem solving and opportunities to practice the skills above all: students who are not afforded the opportunity to attempt problem solving on a regular basis show less achievement growth than students regularly exposed and expected to problem solve (Bottge, Heinrichs, 2004). The National Council of Teachers of Mathematics (NCTM, 1989) recommends that teachers focus on tasks that encourage students "to explore, to guess, and even make and correct errors so they gain confidence in their ability to solve complex problems" (p. 5). One key point to problem solving improvement seems to lay in making the problems relevant to the mathematics curriculum (Leader, Middleton, 2004; Pape, 2003).

While explicitly teaching problem solving skills has long been debated, Resnick (1989) claims "becoming a good mathematical problem solver – becoming a good thinker in any domain - may be as much a matter of acquiring the habits and dispositions of interpretation and sense-making as of acquiring any particular set of skills, strategies or knowledge" (p. 58).

As is always a concern with educators, instructional time impacts lessons of all calibers. Over a five-week period, Higgins (1997) used a warm-up format to address problem solving, and while she carefully mapped out time constraints for her problem solving activities, there was no real connection to any implication that use of warm-ups increases instructional time. This is one area where research was not found to coincide with my research project. While the topic was, in a round-about way, addressed it was not an exact fit to my needs as a researcher. This leads me to believe my research may be unique and informative.

With the research findings in mind, I have chosen to explore the possible impacts of staying within the current trend and necessity to improve problem solving in an action research project in the spring of 2006. While the review shows an abundance of discourse regarding problem solving in general, that there is little evidence of studies involving use of daily problem solving warm-ups indicates such a study may help fill a gap in the available research. This lack of readily available information has prompted me to pursue this area with action research. With such a lack of information regarding this practice, I believe it may prove to be an effective intervention that will afford students the experience and opportunity to become better problem solvers while at the same time help other teachers who may have similar concerns and needs for easily implemented strategies. Should the research findings not show improvement and prove no academic or classroom management benefit exists, the study may benefit others who might have considered trying this idea in their classrooms. Additionally, it may provide a starting basis for continued research along similar lines that, through modification, may prove beneficial to mathematics education as a whole.

Purpose Statement

The purpose of this study is to determine if a daily warm-up (which I previously did not use), posed in "problem-solving" form, will be an effective strategy to:

- a) offer the necessary exposure to "problem solving" and practical applications or transference of mathematical concepts beyond computational practice to improve problem-solving skills as set for the NCA goal to improve overall scores on standardized and state tests.
- b) to determine "improvement" in students' problem solving by observing their willingness and ability to approach problems on their own and noticing behavioral and "approach" changes regarding problem solving. (This may include areas of attitude, effort, variety of strategies students are able/willing to use to solve in addition to finding a successful/correct solution.) While I am also interested in seeing improvement in student competence with communicating their processes and strategies or solutions, I am not particularly focusing on that area with this study.
- c) offer students a more structured, methodical approach that may encourage better organization and time management in general.
 - d) free up more classroom instructional time (take attendance while students are busy completing the daily warm-up, grade one or two warm-up problems each day vs. 20+ homework problems, "spot-check" daily homework, etc.) Additionally, to maximize instructional time by putting the students in a more "mathematical frame of mind" sooner, thereby making them ready to learn the new lesson or concept for that day.

My action research project will involve the use of daily problem solving warm-ups to address the questions of:

- 1) How can I best utilize the amount of instructional time I've been given?
- 2) How can I help students become better problem solvers?
- 3) Can daily warm-ups posed in problem-solving form simultaneously enhance classroom management, improve grading practices and strengthen problem solving skills?
- 4) Is repeated exposure to problem solving situations an effective means of improving student attitudes regarding problem solving in general?

Data collection in the form of daily problem-solving results, state assessments, an alternate assessment, student interviews and attitude surveys as well as standardized (Terra-Nova) test scores occurred during the spring semester of 2006 in the researcher's 4th period 8th grade math classroom.

Method

Due to some unforeseen hold-ups with beginning the actual action research project, my initial outline for procedure and timeline didn't work out as I had planned. Variations and modifications were necessary to fit the new needs of the time allowed for this study. In an effort to make the study as valid as possible and show growth or change to some degree, I found it necessary to eliminate some aspects of the study altogether and gather less data than anticipated.

The first type of data used was the culmination of daily problems kept in individual student "Problem-Solving Notebooks." I gave each student a small spiral notebook, color-coded for each student to make grabbing the notebook upon entering the room easier. This also helped save time for me as I didn't have to file or alphabetize the notebooks each day after grading them. The notebooks were stored in a file box by the door. As the students entered the room each day, they would find their "color" and take their book to their table, open to the day's problem and begin solving. Typically, the problems were designed to take five minutes or less (to approximate amounts of time I'd spent prior to

the study taking attendance, etc.) but sometimes exceeded that. As they finished, they'd put the book back in the file box and class would begin since I'd used the time they were solving to take care of pre-instruction operations such as attendance, make-up work and any discussion that needed to occur with the deaf education/sign language interpreter that is present every day for the deaf student in this class. At the end of the day, I would grade the solutions using the rubric shown in Appendix A and enter the new problem for the next day's round. A record was kept throughout the time frame of the project for each of the problem's scores.

An alternate problem-solving assessment (see Appendix B) was given twice during the duration of the study - once in the beginning phase in February and once near the end in April. Overall scores (graded with the rubric) were recorded. Results of the two assessments were then compared to show if growth or improvement was made in any or all areas of the problem-solving skills or abilities of the students.

The standardized test (Terra-Nova) scores were gathered by the school's counselor for the previous year and the current year for the students in this test group. Areas compared were with the "Problem Solving" and "Math Composite" strands for the two years. While other factors may affect performance on these tests and changes may not be attributed wholly to the implementation of the daily problem-solving activities, it is possible the changes found from one year to the next are due in part to these instructional differences and are included for that reason.

It should be noted the students were de-identified by the counselor and placed in random order assuring the researcher had no knowledge of what scores belonged to which student. Therefore, in the data gathered for these tests the student numbers will not coincide with the student numbers used for other areas of data collection. Whenever possible, student numbers are used as a means of comparing various data types across the board. However, this will not be the case for the Terra-Nova data.

As primary researcher, I administered a math problem-solving attitude survey (Appendix C) near the onset and the conclusion of the research period. The data gathered was used to track changes in student attitudes and perceptions of problem-solving as a whole. Student interviews were used to record data regarding feelings, beliefs and attitudes regarding problem solving in general as well as the research project as a whole. Coupled with the Likert scale survey, the data generated was used to form an overall idea of what the students believed would or could affect their understanding, comfort level and use of problem solving skills and/or abilities.

The researcher also attempted to keep a weekly journal on thoughts and feelings about the project, its general implementation process and progression, student reactions observed and overall progress of the tasks being performed. Many times the journal acted as a means of clarifying what changes needed to be made or what modifications were necessary. It was also used to help determine at what points (specifically) it might be good to administer the attitude survey or assessments.

Analysis

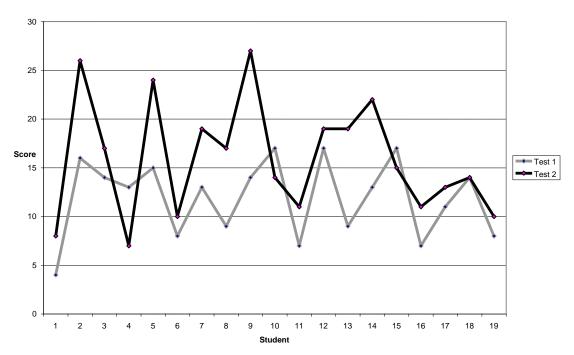
Regarding student attitude, I found the data gathered from the Likert scale survey was quite difficult to assess or analyze in its entirety. Thus, I chose to make comparisons based on each statement and how it was answered by each student and then compared how this "averaged out" for the group. (See Appendix D) For example, for statement one ("I like problem-solving.") the response average for the group was 3 or "I Somewhat Disagree" in the first survey but fell just short of that at 2.7 for the second survey. This would indicate the overall response became more negative at the end of the research since the average would have fallen in the "I Strongly Disagree" range. Clearly this would mean student attitude did not improve as a result of this study. However, when looking at other statements and the responses recorded this was not necessarily the case. In statement 7 ("Daily warmups help prepare me for the new lesson.") the initial average was within the "I Strongly Disagree"

range but the final average fell within the "I Somewhat Disagree" range which would indicate an improved attitude or appreciation. With this in mind, I would question the make-up of my survey and believe a better model would alleviate some of this confusion. This format (and perhaps the questions themselves) did not lend well to easy or clear analysis of the data the survey rendered. Keeping all the statements as clearly "positive" (or negative) a more definite reading or result may occur (or at least be easier to analyze.) Also, the number of statements on the survey may have been too large for the purpose of this study. It is likely that by limiting the number of survey statements to 10 rather than 20 would have been adequate for gathering the information I wanted to find. While I attempt to use what data I can from this survey in conjunction with other data, I was unable to concisely represent the findings based on this survey. (Appendix D shows the spreadsheet data for the survey statements.)

In turning to the other methods of assessing student attitude, my journal entries of "meeting with some resistance and even some defiance regarding problem solving" and "students are beginning to complain about having to do problem-solving every day" or "This is stupid! Why do we have to do this again?" and comments from student interviews such as "I hate it. I wish we didn't have to do it." "I don't really like it, but I guess it's okay. I don't think it's really helping anything, though." would steer me to believe such a thing as "overexposure" may be indicated. (Overall, the negative comments outnumbered the positive comments. In tallying the comments from my journal and the taped student interviews, there were 27 negative comments, 14 indifferent comments and 12 positive comments. However, it should be noted that this may be misleading as for whatever reason my tendency to journal regarding negative comments seemed to take precedence to journaling about the positive ones.) My general assertion regarding student attitude is one of a very tentative nature. In some aspects, attitude or opinion was improved and in some areas they were diminished. Overall, I would have to say the change in attitude (either positively or negatively) was not terribly significant within the time frame of this study. (Other data from the Likert scale survey can be seen in Appendix E.)

Can daily problem-solving warm-ups improve student performance? By looking at the data gathered from test results and the warm-ups themselves, I'm encouraged and inclined to answer yes, they can! That is to say, *sometimes* and for *some* students. Not all students in my 8th grade class took to the task with resolve and determination. (Is this not true of any middle school class, though?) For those who took the new routine seriously and gave it at least some effort (worked on the problems with or without arriving at a solution), the results were encouraging. For those who gave minimal or no effort (wrote "I don't know" or simply guessed a number) the results were to be expected: little or no improvement could be noted. While I expected this, I still found it disappointing. Six or seven students showed a marked improvement and interest in problem solving skills and abilities. Some students (eight or nine overall) showed slight improvements. And, unfortunately, some students (3 based on the data) seemed to lose some of their ability or skills. As shown in the charts below, these growth (or lack of growth!) patterns can be seen based on the various methods of data comparisons.

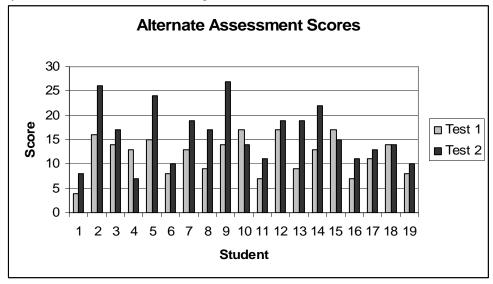
Alternate Assessment Line Graph



This line graph shows the comparison of the alternate assessment given the first time in February and the second time in April. The graph shows there were three students whose scores decreased, one student whose score remained the same and the remaining students' scores improved. The bar graph below shows the same data but is included for those who visually prefer this type of graph.

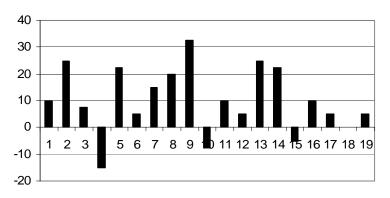
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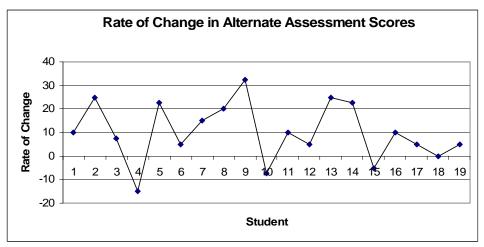
This bar graph is intended to better show at a glance student improvement and to what degree the scores changed from one assessment to the other. While the line graph above readily shows the different abilities among the students in general, the bar graph displays the data with more of a focus on growth or decline for the individual students.



This bar graph and line graph below show the rate of change in scores for each student. Again, the four students who did not improve their scores are shown as those points plotted at zero or below.

Rate of Change from Test 1 to Test 2





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Alternate Assessment Data

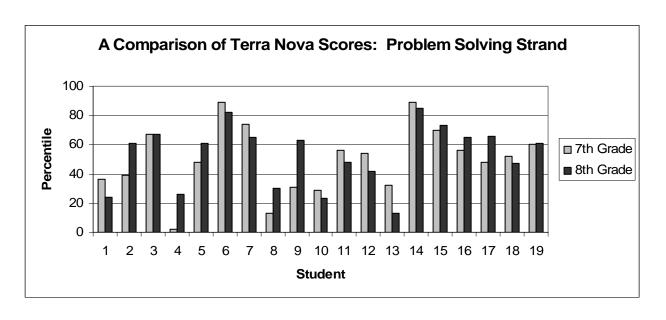
Student			Rate of Change
	2-23-06	4-12-06	100/
1	4	8	+ 10%
2	16	26	+ 25%
3	14	17	+ 7.5
4	13	7	- 15%
5	15	24	+ 22.5%
6	8	10	+ 5%
7	13	19	+ 15%
8	9	17	+ 20%
9	14	27	+ 32.5%
10	17	14	- 7.5%
11	7	11	+ 10%
12	17	19	+ 5%
13	9	19	+ 25%
14	13	22	+ 22.5%
15	17	15	- 5%
16	7	11	+ 10%
17	11	13	+ 5%
18	14	14	0
19	8	10	+ 5%
SUM	226	303	192.5
MEAN	11.89474	15.94737	10.13158%
MEDIAN	13	15	10%
MODE	13, 14, 17	19	5%
RANGE	13	20	17.5%
andard Deviation	3.94257	5.939264	12.37363

This table of data was used to generate the charts to reflect patterns of growth (or decreases) and rates of change in scores from Test 1 to Test 2. Other measures of central tendency and standard deviations are included as notes of interest in comparing the data. Clearly, movement was more significant for some students than for others. The students who showed the most improvement tend to be the students who put forth the most sincere effort and are typically considered "top" students in the class regardless of the content or activity.

The following data from the Terra-Nova standardized test was used to make the charts depicting rate of change from 7th to 8th grade for the students in this research project. Data from two strands from this test were gathered: Problem Solving and Math Computation. The researcher elected to not use the data for math computation as part of this research project.

Terra-Nova Data: Problem Solving Strand

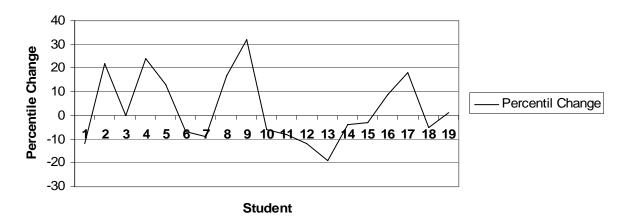
Ctudont			Daraantila
Student	7 th Grade	oth Ossala	Percentile
Number		8 th Grade	Change
1	36	24	-12
2	39	61	22
3	67	67	0
4	2	26	24
5	48	61	13
6	89	82	-7
7	74	65	-9
8	13	30	17
9	31	63	32
10	29	23	-6
11	56	48	-8
12	54	42	-12
13	32	13	-19
14	89	85	-4
15	70	73	-3
16	56	65	9
17	48	66	18
18	52	47	-5
19	60	61	1
Mean	49.73684	52.73684	2.684211
St. Dev.	23.12008	21.06825	14.4147



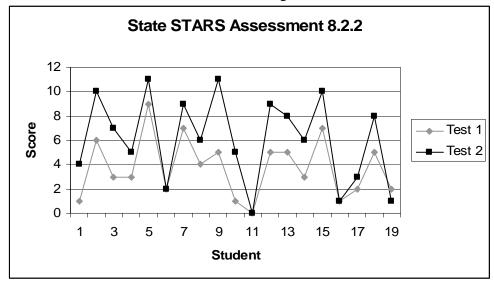
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Here, the "Problem Solving" strand compares student performance over the span of one year based on percentiles. The bar graph above shows the two years of testing side-by-side. The line graph shows the rate of change from one year to the next. Again, movement seemed to be significant for some students while less significant for others. This data indicates there were more students who did not improve or actually decreased their scores than there were based on the alternate assessment scores.

Terra-Nova Problem Solving Percentile Change



Finally, the state "STARS" assessment 8.2.2 was used to compare student growth or improvement with problem-solving skills. The students were given the assessment once in March and once in May. The data gathered is summarized in the chart below using the tabled data.



This graph compares the two assessment scores and shows that many students improved their scores when taking the assessment the second time while some remained the same. Only one student scored lower on the second assessment.

Data for Assessment 8.2.2

				Data Arranged From	Data Arranged From	
Student	Test 1 Score	Test 2 Score	Difference	Least to Greatest	Least to Greatest	
1	1	4	+3	0	0	
2	6	10	+4	1	1	
3	3	7	+4	1	1	
4	3	5	+2	1	2	
5	9	11	+2	2	3	
6	2	2	+0	2	4	
7	7	9	+2	2	5	
8	4	6	+2	3	5	
9	5	11	+6	3	6	
10	1	5	+4	3	6	
11	0	0	+0	4	7	
12	5	9	+4	5	8	
13	5	8	+3	5	8	
14	3	6	+3	5	8	
15	7	10	+3	5	9	
16	1	1	+0	6	10	
17	2	3	+1	7	10	
18	5	8	+3	7	11	
19	2	1	-1	9	11	
			2.368421	3.736842	6.052632	mean
			3	3	6	median
			3	5	8	mode
			7	9	11	range St.
				2.445906	3.503549	Dev.

Student attitudes may not have changed greatly (they still may not "like" problem solving) but their comfort level when presented with problem solving may have increased. I did feel that students didn't approach the problem solving with as much trepidation and doubt as they did prior to this study, but I still saw an overall dislike for and dread of having to do the work. Many of the students did not believe the daily warm-ups made a difference (as seen in the survey results, researcher's journal and the student interviews) and preferred we didn't do them.

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Students no longer "milled around" when coming into class, tardies were less frequent and when it was time to start the lesson students were seated, in "work" mode and ready to learn. Tardies were indeed less frequent, students did come into class and get right to work and generally they were much more prepared for the content of the day's lesson because their minds were already in "math mode." This was a "sometimes" situation, though. While I did see some improvement with these things, it didn't become an everyday occurrence and it was definitely not ALL students. Several journal entries included comments such as, "Wow! Every student was at their table working on their problem-solving before class time actually started!" and "They've gotten so good at just coming into the room, grabbing their notebook and beginning their work! There's some grumbling and complaining as they do it, but they're doing it!" In looking at the attendance record, I found there were typically four or five tardies recorded each week prior to the problem-solving research. During the span of the study, tardies were generally less than two per week. For the few weeks of school remaining after the wrap-up of the research, tardies began to rise again.

Many students showed an overall improvement in their problem-solving skills. Some students (due to attitude or willingness to work or put forth effort) did not show growth while some even appeared to lose some of their ability to successfully problem-solve throughout the study. One student in particular continued to answer the daily problems with "I don't know!" or "I don't get it!" as their answer, with no evidence of even trying to solve the problem or apply a strategy of any kind. Could this growth be attributed to the extra efforts brought about by implementing daily problem-solving warm-ups? The scores for assessments and standardized tests indicate growth did occur for many students. Whether this growth is a "normal" or expected amount of growth for students of this age in a one-year span is unknown to this researcher. I would surmise a "normal" growth would show the students maintaining nearly the same level of proficiency (or falling in approximately the same percentile ranking) as they did the previous year since the tests are targeted for grade appropriateness.

Growth or improvement beyond those levels would indicate the skills were enhanced beyond what would be customary for that one-year span. Students who markedly changed their level of proficiency or percentile ranking could then be viewed as evidence the daily warm-ups did indeed impact their problem-solving skills.

Interpretation

Based on my findings and the data gathered throughout this study, I am still not exactly sure to what extent the implementation of daily warm-ups affected the students' abilities to problem-solve. This may be due in part to the short duration of the study and time frame within which it fell. While it seems logical to believe an impact was made for many students, to what extent that impact can be directly related to the warm-ups remains unknown to this researcher. Having observed the students throughout the study, witnessed their work and the changes in their work or results and listening to their comments I could say the project definitely affected some students and their problem-solving abilities. As I've mentioned, some students approached the process with enthusiasm and a will to succeed. Others saw it as a necessary evil. The others fell somewhere between the two opinions.

As with any classroom learning, some techniques, procedures or methods are very effective for some students while failing miserably to reach others. This could certainly be the case for using daily warm-ups of a problem-solving nature. Some students find a change in the customary routine refreshing while others view it as a hindrance or "extra work." Could this have been the case with the problem-solving activity this study presented? I would have to say for some more than likely. But I'm still plagued by the question of, "Exactly how much impact did the actual warm-ups have on the overall problem solving skills and abilities?" Therefore, I feel compelled to continue testing the proposal that this strategy will make a difference. I believe, given more time to collect greater amounts of data and make further observations (as well as affording more time for the greater exposure of daily problem-solving), I will be able to answer that question more definitively.

To make broad and sweeping statements regarding the success or failure of this study to produce the desired results after only a few months would be irresponsible. However, I did find the results compelling and encouraging enough to believe it has merit and deserves further attention.

In conferring with Dr. Heaton throughout the duration of the study I commented several times that I viewed this initial study as a "trial run" (mainly due to the time constraints and unforeseen hold-ups or setbacks) by which I could determine what worked and what didn't. Having practiced the procedure for this short time period, I believe I now have a better idea of what needs to take place at what times, what modifications need to be made and how to best organize the various aspects of the study. Data collection, the survey and interview schedules and formats of the forms and notebooks used are crucial to making the study (and ultimately the results of the study) more reliable and evidentiary. It is my intention to make these changes and further explore the possibilities and outcomes a similar study may hold for my students in the upcoming year. The sheer fact that I remain intrigued, interested and compelled to maintain a focus on the potential growth opportunities use of daily problem-solving warm-ups can have on overall student performance assures me that there is still much to learn regarding this idea.

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APPENDIX A

Math - Problem Solving General Rubric

Teacher Name: Mrs. French Student Name:

	<u> </u>	T	<u> </u>	
CATEGORY	4	3	2	1
Mathematical Concepts	Explanation shows complete understanding of the mathematical concepts used to solve the problem(s).	Explanation shows substantial understanding of the mathematical concepts used to solve the problem(s).	Explanation shows some understanding of the mathematical concepts needed to solve the problem(s).	Explanation shows very limited understanding of the underlying concepts needed to solve the problem(s) OR is not written.
Mathematical Reasoning	Uses complex and refined mathematical reasoning.	Uses effective mathematical reasoning	Some evidence of mathematical reasoning.	Little evidence of mathematical reasoning.
Mathematical Errors	90-100% of the steps and solutions have no mathematical errors.	Almost all (85-89%) of the steps and solutions have no mathematical errors.	Most (75-84%) of the steps and solutions have no mathematical errors.	More than 75% of the steps and solutions have mathematical errors.
Explanation	Explanation is detailed and clear.	Explanation is clear.	Explanation is a little difficult to understand, but includes critical components.	Explanation is difficult to understand and is missing several components OR was not included.
Strategy/Procedures	Typically, uses an efficient and effective strategy to solve the problem(s).	Typically, uses an effective strategy to solve the problem(s).	Sometimes uses an effective strategy to solve problems, but does not do it consistently.	Rarely uses an effective strategy to solve problems.

Appendix B

Alternate Assessment – Page 1

- 1. If a gardener has 28 feet of lumber to build a flower box that must be a minimum of 4 feet wide, what are the possible lengths of the flower box? (Assume that each length and width must be in whole feet lengths with no fractions used.)
- 2. Five friends meet for lunch. Each friend says "Hello!" to each other person as they arrive. How many "Hellos" are said by the five friends combined? What if there were 10 friends who met for lunch? What if there were "n" friends?
- 3. Find the next three terms in the sequence 2, 4, 3, 6, 5...
- 4. Here is a multiplication problem that was partially erased.

Can you fill in a possible set of missing digits?

How many possible answers are there? What are they?

5. Bill walks 5 blocks to school each day. Some days, he walks two blocks north and 3 blocks east. Sketch a map of John's house in relation to the school and determine the total number of ways John could walk to school without backtracking or going out of his way.

Appendix B (continued)

6. Marietta's favorite cookie recipe calls for 1 ½ cups of sugar to make 18 cookies. She has enough of the other ingredients to make however many cookies she wants, but she only has 2 ¾ cups of sugar. If she uses all her sugar, how many cookies can Marietta make? Will there be "partial" cookies?

7. John has 4 pets; a bird, a fish, a cat and a dog. Their names, in no particular order, are Skittles, Blue, Mack and Daisy. Each pet is housed in a different room of the house. Determine each pet's name and where it "lives" in the house using the clues and chart below.

Daisy and the pet who lives in the living room are the only females.

Skittles lives in the kitchen, but he often sneaks in to visit Mack in the den.

John's dog and the other male pet do not live in the bedroom.

The bird and dog both live in rooms that start with the same letter as their species.

Skittles likes to watch the fish.

	Skittles	Mack	Blue	Daisy	Living Room	Bedroom	Den	Kitchen
Bird								
Cat								
Fish								
Dog								
Living Room								
Bedroom								
Den								
Kitchen								

8. Arrange the squares to form one regular polygon (sides must match up by their entire length as
shown below.) Find the maximum perimeter and area that can be made for each polygon. Find the
minimum perimeter and area. Explain what you notice about area and perimeter for the number of
squares given.

a)			Example:	
b)				
c)			NOT like this:	

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Appendix C

Daily Problem-Solving Warm-ups Survey

Please answer the following questions to the best of your ability to accurately describe your thoughts and feelings regarding our use of daily math warm-ups and problem-solving. **Mark ONE answer for each question.** Place your completed survey in the "SURVEY BOX". Thank you for helping me to understand your thoughts.

Question	Strongly Agree	Somewhat Agree	Somewhat Disagree	Strongly Disagree	I Don't Know
1. I like problem-solving.					
2. I feel confident when problem-solving.					
3. Problem-solving is easier when working with a group/partner.					
4. I can get the correct solution most of the time.					
5. Problem solving everyday has helped me become a better problem solver.					
6. I feel more ready to learn math after working on problem-solving warm ups.					
7. Daily warm-ups help prepare me for the new lesson.					
8. Problem-solving is an important skill that relates math to the real world.					
9. I don't usually know where to start when problem-solving.					
10. There is more than one way to solve most problems.					
11. I use different strategies to solve problems depending on the type of problem.					
12. I want to be a better problem solver.					
13. Most people in this class are better problem solvers than me.					
14. Most students cannot be successful problem-solvers because it is too hard.					
15. I will not use problem-solving once I'm no longer taking a math class.					
16. Problem-solving helps me understand why I have to learn certain math concepts.					
17. Problem-solving is a better way to practice and understand math concepts.					
18. Daily warm-ups take too much class time.					
19. I would prefer to do more problem-solving, but it takes too much time.					
20. I don't understand how problem-solving will help me learn mathematics.					

Appendix D - Survey Spreadsheet

	Question 1	Question 2	Question 3	Question 4	Question 5	Question 6
SURVEY 1 (2-9-06)	1	1	2	1	1	1
	2	2	3	1	1	1
	2	3	4	2	2	1
	2	3	5	3	2	2
	2	3	5	3	3	2
	2	4	5	3	3	2
	3	4	5	3	3	3
	3	4	5	3	3	3
	3	4	5	3	3	3
	3	4	5	4	3	3
	3	4	5	4	4	3
	3	4	5	4	4	3
	4	4	5	4	4	3
	4	4	5	4	4	3
	4	4	5	4	4	3
	4	4	5	4	4	3
	4	4	5	4	4	4
	4	4	5	4	4	4
	4	4	5	5	4	5
Mean	3	3.578947368	4.684210526	3.315789474	3.157894737	2.736842105
Strongly Agree	0	0	16	1	0	1
Somewhat Agree	7	14	1	9	9	2
Somewhat Disagree	6	3	1	6	6	10
Stongly Disagree	5	1	1	1	2	3
I don't know	1	1	0	2	2	3
Survey 2 (4-10-06)	2	1	1	1	1	1
	2	2	2	1	1	1
	2	2	2	2	2	1
	2	2	2	2	2	2
	2	3	2	3	2	2
	2	3	4	3	2	2
	2	3	5	3	3	2
	2	3	5	3	3	2
	3	3	5	3	3	2
	3	3	5	3	3	3
	3	3	5	4	3	3
	3	4	5	4	4	3
	3	4	5	4	4	3
	3	4	5	4	4	3
	3	4	5	4	4	3
	4	4	5	4	4	3
	4	4	5	4	4	4
	4	4	5	5	4	4
	4	4	5	5	5	4
Mean	2.789473684	3.157894737	4.105263158	3.263157895	3.052631579	2.44444444
Strongly Agree	0	0	13	2	1	0
Somewhat Agree	4	8	1	7	7	3
Somewhat Disagree	7	7	0	6	5	7
Stongly Disagree	8	3	4	2	4	6
I don't know	0	1	1	2	2	3

Appendix D – Survey Spreadsheet (continued)

Question 7	Question 8	Question 9	Question 10	Question 11	Question 12	Question 13
1	1	2	2	1	1	1
1	1	2	3	2	2	1
1	1	2	3	3	2	2
2	2	3	3	3	2	2
2	3	3	3	3	3	2
2	3	3	3	3	3	2
2	3	3	4	3	3	3
3	3	3	4	3	3	3
3	4	3	4	4	3	3
3	4	3	4	4	3	3
3	4	3	4	4	4	3
3	4	3	4	4	4	3
3	4	4	4	4	4	3
3	4	5	4	4	4	3
4	5	5	4	4	4	4
4	5	5	5	5	4	4
4	5	5	5	5	5	5
4	5	5	5	5	5	5
4	5	5	5	5	5	5
2.736842105	3.473684211	3.526315789	3.842105263	3.631578947	3.368421053	3
0	1	6	4	4	3	4
5	4	1	9	7	6	8
7	6	9	5	6	6	2
4	5	3	1	1	3	3
3	3	0	0	1	1	2
1	1	1	1	1	1	1
1	1	2	1	2	1	1
2	2	2	3	3	2	2
2	2	3	4	3	2	2
3	3	3	4	3	2	2
3	3	3	4	3	2	2
3	3	3	4	3	3	2
3	3	3	4	4	3	3
3	4	3	4	4	3	3
3	4	3	4	4	4	3
3	4	4	4	4	4	3
4	4	4	4	4	4	3
4	4	4	4	4	4	3
4	4	4	5	4	4	4
4	4	4	5	4	4	4
4	5	4	5	4	5	4
4	5	4	5	5	5	4
5	5	5	5	5	5	4
5	5	5	5	5	5	4
3.210526316	3.473684211	3.368421053	3.947368421	3.631578947	3.315789474	2.842105263
2	4	2	6	3	4	5
6	7	7	10	9	6	6
7	4	7	1	5	3	6
2	2	2	0	1	4	0
2	2	1	2	1	2	2

Daily Problem-Solving Warm-Ups 30

Appendix D – Survey Spreadsheet (continued)

Question 14	Question 15	Question 16	Question 17	Question 18	Question 19	Question 20
1	1	1	1	1	1	1
1	1	1	2	1	1	1
1	1	1	2	2	3	1
1	2	1	2	3	3	2
3	2	2	3	3	4	2
4	2	3	3	3	4	4
4	3	3	4	3	4	4
4	3	3	4	3	4	4
4	3	3	4	4	5	4
4	4	4	4	4	5	4
4	4	4	4	4	5	4
4	4	4	4	4	5	4
4	4	4	4	5	5	4
4	4	4	4	5	5	5
5	5	4	4	5	5	5
5	5	4	4	5	5	5
5	5	4	5	5	5	5
5	5	4	5	5	5	5
5	5	5	5	5	5	5
3.578947368	3.315789474	3.105263158	3.578947368	3.684210526	4.157894737	3.631578947
0	5	1	3	1	0	2
1	5	9	2	5	2	0
9	3	4	10	4	4	8
5	3	1	3	7	11	6
4	3	4	1	2	2	3
1	1	1	2	1	3	1
1	1	1	2	2	3	1
1	3	1	2	2	4	2
2	3	1	3	2	4	2
3	3	1	3	2	4	2
3	4	2	3	3	4	3
3	4	2	3	3	4	3
4	4	3	4	4	5	3
4	4	3	4	4	5	4
4	4	3	4	4	5	4
4	4	3	4	4	5	4
4	4	4	4	4	5	4
4	4	4	4	4	5	4
4	4	4	4	4	5	4
4	5	4	4	4	5	4
5	5	4	4	4	5	5
5	5	4	4	4	5	5
5	5	4	4	5	5	5
5	5	5	4	5	5	5
3.473684211	3.789473684	2.842105263	3.473684211	3.421052632	4.526315789	3.421052632
1	0	1	0	4	0	3
3	3	7	12	2	2	3
8	9	4	4	10	5	7
4	5	2	3	2	12	4
3	2	5	0	1	0	2

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Appendix EOther Survey Data

Question #	Student 1	Student 2	Student 3	Student 4	Student 5	Student 6	Student 7	Student 8	Student 9	Student 10
1	2	2	3	2	2	3	2	4	4	4
2	2	4	4	4	4	3	3	4	4	4
3	2	5	5	5	5	3	5	5	5	5
4	3	4	4	3	4	4	4	4	4	4
5	3	3	4	3	4	3	2	1	4	4
6	3	3	3	3	3	3	2	1	4	5
7	3	3	3	3	4	2	3	4	4	4
8	4	4	4	4	3	3	2	1	5	4
9	2	5	3	3	3	3	3	3	5	2
10	3	5	4	4	5	4	3	4	5	3
11	3	5	3	3	4	4	4	3	4	5
12	4	4	5	3	3	3	2	4	3	2
13	5	5	3	1	3	2	4	1	3	3
14	4	4	4	1	4	4	5	4	5	3
15	1	2	5	5	3	4	3	4	5	3
16	1	4	3	3	3	4	3	4	4	4
17	4	3	3	4	2	4	2	4	5	4
18	5	3	5	3	1	4	3	4	5	5
19	5	5	3	5	1	5	5	4	4	3
20	4	5	4	4	1	4	2	4	5	2
Sum	63	78	75	66	62	69	62	67	87	73
Question	Student	student	student	student	student	student	student	student	student	student
#	1	2	3	4	5	6	7	8	9	10
1	2	3	2	2	2	3	3	4	4	4
2	2	4	4	3	4	3	3	4	4	4
3	2	5	5	4	5	5	5	5	5	5
4	3	3	3	4	4	3	3	3	5	4
5	4					U				
6		4	3	4	2	4	4	3	5	3
6	2	3	3	4	2		4 2	3 3	5 1	2
7	2 4	3	3	4 5	2 2	4	4 2 3	3 3 4	5 1 4	
7	2 4 4	3 4 5	3 3 4	4 5 4	2 2 3	4 1 1 4	4 2 3 3	3 3	5 1 4 5	2
7 8 9	2 4 4 3	3 4 5 5	3	4 5 4 4	2 2	4	4 2 3 3 3	3 3 4	5 1 4 5 5	2
7 8 9 10	2 4 4 3 4	3 4 5 5 5	3 3 4 3 4	4 5 4 4 5	2 2 3 4 4	4 1 1 4 3 4	4 2 3 3 3 3	3 3 4 4 1 4	5 1 4 5 5 4	2 3 1 4 5
7 8 9 10 11	2 4 4 3 4 5	3 4 5 5 5 4	3 3 4 3 4 3	4 5 4 4 5 5	2 2 3 4 4 4	4 1 1 4 3 4	4 2 3 3 3 3 4	3 3 4 4 1 4 3	5 1 4 5 5 4 4	2 3 1 4 5
7 8 9 10 11 12	2 4 4 3 4 5 4	3 4 5 5 5 4 4	3 3 4 3 4	4 5 4 4 5 5 3	2 2 3 4 4 4 2	4 1 1 4 3 4 1 5	4 2 3 3 3 3 4 2	3 3 4 4 1 4 3 3	5 1 4 5 5 4	2 3 1 4 5 4 4
7 8 9 10 11 12	2 4 4 3 4 5 4 2	3 4 5 5 5 4 4 4	3 3 4 3 4 3 3	4 5 4 4 5 5 3 3	2 2 3 4 4 4 2 3	4 1 1 4 3 4 1 5	4 2 3 3 3 4 2 4	3 3 4 4 1 4 3 3	5 1 4 5 5 4 4 5	2 3 1 4 5 4 4 2
7 8 9 10 11 12 13	2 4 4 3 4 5 4 2 5	3 4 5 5 5 4 4 4 5	3 4 3 4 3 3 1	4 5 4 4 5 5 3 3	2 2 3 4 4 4 2 3 4	4 1 1 4 3 4 1 5 3 5	4 2 3 3 3 3 4 2 4 3	3 3 4 4 1 4 3 3	5 1 4 5 5 4 4 5	2 3 1 4 5 4 4 2 4
7 8 9 10 11 12 13 14	2 4 4 3 4 5 4 2 5 4	3 4 5 5 5 4 4 4 5	3 4 3 4 3 3 1 1 5	4 5 4 4 5 5 3 3 3	2 2 3 4 4 4 2 3 4	4 1 1 4 3 4 1 5 3 5	4 2 3 3 3 4 2 4 3 4	3 3 4 4 1 4 3 3	5 1 4 5 5 4 4 5	2 3 1 4 5 4 4 2 4 3
7 8 9 10 11 12 13 14 15	2 4 4 3 4 5 4 2 5 4 2	3 4 5 5 5 4 4 4 5 4	3 4 3 4 3 3 1 1 5 3	4 5 4 5 5 3 3 3 4	2 2 3 4 4 4 2 3 4 4 3	4 1 1 4 3 4 1 5 3 5 4	4 2 3 3 3 4 2 4 3 4	3 3 4 4 1 4 3 3 4 1 1	5 1 4 5 5 4 4 5 4 5	2 3 1 4 5 4 4 2 4 3 4
7 8 9 10 11 12 13 14 15 16	2 4 4 3 4 5 4 2 5 4 2 2	3 4 5 5 5 4 4 4 5 4 4 3	3 4 3 4 3 3 1 1 5 3 4	4 5 4 4 5 5 3 3 3 4 4	2 2 3 4 4 4 2 3 4 4 3 4	4 1 1 4 3 4 1 5 3 5 4 1 4	4 2 3 3 3 4 2 4 3 4 4	3 3 4 4 1 4 3 3 4 1 1 1 3	5 1 4 5 5 4 4 5 4 5 1 4	2 3 1 4 5 4 4 2 4 3 4 3
7 8 9 10 11 12 13 14 15 16 17	2 4 4 3 4 5 4 2 5 4 2 2 2	3 4 5 5 5 4 4 4 5 4 4 3 4	3 4 3 4 3 1 1 5 3 4 3	4 5 4 4 5 5 3 3 3 4 4	2 2 3 4 4 4 2 3 4 4 3 4 2	4 1 1 4 3 4 1 5 3 5 4 1 4 4	4 2 3 3 3 4 2 4 3 4 4 4 4 2	3 3 4 4 1 4 3 3 4 1 1 1 1 3	5 1 4 5 5 4 4 5 4 5 1 4	2 3 1 4 5 4 2 4 3 4 3 4
7 8 9 10 11 12 13 14 15 16 17 18	2 4 4 3 4 5 4 2 5 4 2 2 2 5	3 4 5 5 5 4 4 4 5 4 4 5 4 5 5	3 4 3 4 3 1 1 5 3 4 3 5	4 5 4 4 5 5 3 3 3 4 4 4	2 2 3 4 4 2 3 4 4 3 4 2 5	4 1 1 4 3 4 1 5 3 5 4 1 4 4 4 4	4 2 3 3 3 4 2 4 3 4 4 4 4 2 5	3 3 4 4 1 4 3 3 4 1 1 1 3 4	5 1 4 5 5 4 4 5 4 5 1 4 4 3	2 3 1 4 5 4 4 2 4 3 4 3 4 5
7 8 9 10 11 12 13 14 15 16 17 18 19 20	2 4 4 3 4 5 4 2 5 4 2 2 2 2 5	3 4 5 5 5 4 4 4 5 4 4 3 4 5 5	3 4 3 4 3 1 1 5 3 4 3 4	4 5 4 5 5 3 3 3 4 4 4 4 5	2 2 3 4 4 2 3 4 4 3 4 2 5 4	4 1 1 4 3 4 1 5 3 5 4 1 4 4 4 4 4 4	4 2 3 3 3 4 2 4 3 4 4 4 2 5 4	3 3 4 4 1 4 3 3 4 1 1 1 3 4 4 4	5 1 4 5 5 4 4 5 4 5 1 4 4 3 4	2 3 1 4 5 4 2 4 3 4 3 4 5 1
7 8 9 10 11 12 13 14 15 16 17 18	2 4 4 3 4 5 4 2 5 4 2 2 2 5	3 4 5 5 5 4 4 4 5 4 4 5 4 5 5	3 4 3 4 3 1 1 5 3 4 3 5	4 5 4 4 5 5 3 3 3 4 4 4	2 2 3 4 4 2 3 4 4 3 4 2 5	4 1 1 4 3 4 1 5 3 5 4 1 4 4 4 4 4 4 4 6 6	4 2 3 3 3 4 2 4 3 4 4 4 2 5 4 68	3 3 4 4 1 4 3 3 4 1 1 1 3 4	5 1 4 5 5 4 5 4 5 1 4 3 4 76	2 3 1 4 5 4 2 4 3 4 5 1 69

$Appendix \ E-(continued)$

Other Survey Data

Question #	Student 11	Student 12	Student 13	Student 14	Student 15	Student 16	Student 17	Student 18	Student 19
1	4	4	3	4	3	4	3	3	13
2	4	4	4	4	4	4	4	3	3
3	4	5	5	5	5	5	5	5	5
4	3	3	3	1	5	4	3	1	2
5	4	4	4	4	3	4	3	1	2
6	3	1	3	3	3	4	2	1	2
7	3	1	2	1	3	4	2	1	2
8	4	5	3	5	1	5	1	3	5
9	5	3	4	3	5	5	5	3	2
10	4	5 5	4	3	3	2	4	4	4
11	5	5	3	4	4	4	3	1	2
12	4	4	5 5	2	1	4	3	3	5
13	4	2	3	3	5	3	3	2	2
14		5	5 5	3 1	5 1		3 1	4	5
15	4	5 5	5 5	•	=	4	2	4 1	5 2
16	4		5 4	4 1	1 4	4 4	2	1	5
17	4 4	1	4	1 5			2	1	5 5
18		4 5	-	3	4	4	2	1	
19	4 5	5 5	4	3 5	3	5	∠ 1	1	5
20	5 4	5 5	5 5	5 4	5 4	4	•	4	5
Sum	-	_	_	-		5	1	1	5
Questions	80 student	76 student	78 student	65 student	67 student	82 student	52 student	44 student	69 student
#	11	12	13	14	15	16	17	18	19
" 1	4	2	3	3	2	3	2	2	3
2	3	2	3	4	4	3	1	3	2
3	2	5	5	2	5	2	5	5	1
4	4	2	4	1	5	2	4	4	1
5	4	2	4	1	2	3	1	3	2
6	4	2	3	3	4	3	3	2	1
7	4	3	3	1	5	2	3	4	3
8	4	4	3	5	2	2	1	3	5
9	4	3	4	3	2	3	4	4	2
10	5	4	4	5	1	4	4	1	5
11	4	4	4	5	4	3	3	3	2
12	3	4	3	1	2	2	1	5	5
13	4	2	3	1	4	4	2	3	2
14	1	4	4	5	4	3	4	4	2 2 5
15	5	4	4	4	3	5	1	4	- 5
16	4	3	4	1	2	3	4	1	5
17	4	2	4	4	2	4	3	4	4
18	1	4	5	5	3	2	4	4	4
19	3	5	4	5	5	5	4	5	5
20	5	2	4	5	3	2	1	3	3
sum	72	63	75	64	64	60	55	67	62
			. •	٠.	.				rm-Ups 33
						Lany 1	10010111 00	51,1118 11 a	ops 55

$Appendix \ E-(continued)$

Other Survey Data

Question # Survey 1	Sum per question	MEAN per question		
1	57	3		
2	70	3.684211		
3	89	4.684211		
4	63	3.315789		
5	60	3.157895		
6	52	2.736842		
7	52	2.736842		
8	66	3.473684		
9	67	3.526316		
10	73	3.842105		
11	69	3.631579		
12	64	3.368421		
13	57	3		
14	68	3.578947		
15	63	3.315789		
16	59	3.105263		
17	68	3.578947		
18	70	3.684211		
19	79	4.157895		
20	69	3.631579		
	1315			
Survey 2	5 0	0.700474		
1	53	2.789474		
2	60 70	3.157895		
3 4	78 63	4.105263		
4 5	62 58	3.263158		
6	48	3.052632 2.526316		
7	40 61	3.210526		
8	66	3.473684		
9	64	3.368421		
10	75	3.947368		
11	69	3.631579		
12	61	3.210526		
13	51	2.833333		
14	66	3.473684		
15	72	3.789474		
16	54	2.842105		
17	66	3.473684		
18	65	3.421053		
19	86	4.526316		
20	65	3.421053		
	1280			