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Implementing distributed practice

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Abstract

Distributed practice is a daily routine where students are exposed to a math problem, asked to solve it, and then explain how they solved it. The idea of short intervals of instruction over a period of time can have remarkable results. This instructional strategy has been cited in numerous research studies, an indication that it may be successful in helping students better understand how they can solve mathematical problems.

This study will try to determine the growth of Jewett Elementary's first grade students as they were exposed to distributed practice over a period of time from first to second quarter during the 2004-2005 school year. The areas that are monitored are addition and thinking skills. The research question to be answered is, did distributed practice increase growth in our first grade students as measured by district and classroom assessments?

IMPLEMENTING DISTRIBUTED PRACTICE

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INTRODUCTION

Purpose

Distributed practice is a instructional math strategy that focuses on more spaced then mass instruction. This instruction is a daily routine where students are exposed to a math problem, asked to solve it, and then explain how they solved it. This practice allows the student to become proficient in specific strategies. As students are exposed to a variety of problems, the teacher guides them in their thinking to provide them with the steps they used in order to solve the problem. Then this is modeled concretely by the teacher and discussed so that students can identify the strategy they used to solve the equation. The idea of short intervals of instruction over a period of time can have remarkable results.

This instructional strategy has been cited in numerous research studies, an indication that it may be successful in helping students better understand how they can solve mathematical problems. This study will try to determine the growth of Jewett Elementary's first grade students as they were exposed to distributed practice over a period of time from first to second quarter during the 2004-2005 school year. The areas that are monitored are addition and thinking skills. The research question to be answered is did distributed practice increase growth in our first grade students as measured by district and classroom assessments?

Significance

The significance of this study will show distributed practice using problem-solving strategies did impact students mathematical skills and thinking. This practice has importance to Jewett Elementary

students and teachers because of its impact on students math skills and valuable components of instruction that teachers need to know in order to produce effective problem solving students. This could be valuable to other schools that struggle with similar issues.

Limitations

The limitation of this study is that there is only data collected from first quarter to second quarter during the 2004-2005 school year. This limits identifying any trends of growth from year to year. Another limitation is that there have only been four chapter assessments administered for the first and second quarter. Furthermore, these assessments come from our new math curriculum that has only been recently implemented. So it would be difficult to distinguish whether improvements were due to the new math curriculum, distributed practice, or both factors.

Other limitations to this study is that only forty students out of the total population of first grade at Jewett Elementary were exposed to the daily distributed practice and assessed through classroom achievement analysis and data. This limits the conclusions that can be drawn compared to full implementation.

LITERATURE REVIEW

Distributed Practice

The terms " distributed practice " can also be described as " spaced " rather than " massed " practice. This practice was recognized as early as 1885 when German psychologist Hermann Ebbinghaus published his seminal work on memory. Over the past century, Ebbinghau's findings have

been repeatedly confirmed and extended. Strong positive effects of spaced practice has been found in a wide variety of contexts.

Carlous Caple summarized this body of research as follows:

> The spacing effect is an extremely robust and powerful phenomenon, and it has been repeatedly shown with many kinds of material. Spacing effects have been demonstrated in free recall, in cued recall of paired associates, in the recall of sentences, and in the recall of text material. It is important to note that these spacing results do generalize to textbook materials, meaning those subjects such as science can be manipulated by spacing effects. Also the effects of spaced study can be very long lasting (Caple, 1996, p.22).

The role of distributed or spaced practice in the learning of mathematics has also been studied. In Suydam's 1985 summary on the role of review in mathematics instruction, she wrote " long term retention is best served if assignments on a particular skills are spread out in time rather than concentrated within a short interval." Suydam also noted that short periods of intense review is better than long periods, and that games provide effective review.

Benefits of Distributed Practice

Translations of Russian textbooks carried out by the University of Chicago School of Mathematics Project (also known as UCSMP) in the 1980's showed that primary Russian grade textbooks were clearly organized to provide spaced rather than massed practice and review (Stigler, Fuson, Ham & Kim, 1986; Fuson, Stigler, & Bartsch, 1988). Also in the early

1980's the UCSMP Resource Development Component began studying mathematics education in the Soviet Union, Japan, China, and other high-achieving countries (Wirszup & Streit, 1987, 1990, 1992). Wirszup found that other nations were much more ambitious in the scope and sequence of mathematics covered (Wirszup & Streit, 1987, 1990, 1992).

International Research Findings

In teaching experiments by UCSMP researchers, children showed readiness for algebra, functions, and data analysis, but all these topic were deferred to later grades or given scant attention in U.S. Even in arithmetic, textbooks in other countries presented topics earlier, had a consistent pattern of spaced practice with mixed operations, included more types of word problems, and more challenging problems than U.S. textbook. Kindergarten and first grade children had notions of doubles and other multiples, a sure grasp of the demands of equal sharing, and a clear understanding of " half of." Multiplication and division were not in the U.S. curriculum until late in second or third grade, and then primarily as rote memorization of the simplest facts (Stigler, Fuson, Ham, & Kim, 1986).

Children also had substantial capabilities from their everyday experience with decimals (money), numbers less than zero (winter temperatures), measurements, and geometry. Not surprisingly, in international studies, U.S. students ranked near the bottom in comparisons with their peers in other industrialized nations (Stevenson, Lee, & Stigler, 1986; McKnight et al., 1987).

Problem Solving Practices

Classroom observers found teaching practices in the higher-achieving nations differ greatly from those in the U.S. For example, research found that Japanese elementary teachers employ more child-centered, and problem solving approaches to instruction in mathematics (Stevenson & Stigler, 1992; Stigler & Perry, 1998). Problems are posed in realistic contexts and students find their own solution method. To support these explorations each Japanese student has a tool kit of manipulatives. Following an exploratory lesson segment, the Japanese teacher asks students to explain their reasoning and multiple solutions. In summary, this pattern consists of problem posing, exploration with manipulatives, and discussion of multiple solutions. This fits well with what we know about how children learn and distributed practice techniques.

Investigations showed that an important step in solving a problem is choosing a model or representation for the problem situation (Polya, 1948, 1962; Lesh, Post, & Behr 1987; Schoenfeld, 1987; Janvier, 1987). Research and theorists stressed the importance of natural language, concrete models, physical or mental vision images (including pictures, graphs, and diagrams), and symbols in representing mathematical ideas (Bruner, 1964a, 1964b; Lesh, Post & Behr, 1987; Silver, 1987; Hiebert, 1988). Also facility with multiple representations, especially the ability to translate among representations, was found to be important in problem solving.

Everyday Mathematics authors (Bell & Bell, 1998), director of the UCSMP elementary component, and other educational researchers established the

foundation for problem-solving curriculum illustrated in Figure 1.

Figure 1. Problem Solving Curriculum

1. Children begin school with a great deal of knowledge and intuition on which to build; by making use of this knowledge, far more can be accomplished in the primary grades than has traditionally been supposed
2. The curriculum should begin with children's experience and should work to connect that experience with the discipline of mathematics; the materials should encourage the children's own construction of knowledge.
3. Curriculum development should proceed grade by grade starting at kindergarten so that each grade can build on proven outcomes of the previous grade.
4. The curriculum should be more than just arithmetic, geometry, data analysis, measurement, probability, algebra, and problem solving can be taught in elementary school; the curriculum should include rich problems, mathematical modeling and cross curricular connections.
5. The curriculum should be balanced: concepts, skills, facts, and tools are all necessary.
6. Excellent instruction is important.
7. Reform must take account for the working lives of teachers, teachers should be active collaborators in designing the curriculum.
8. The pace should be brisk
9. Topics should be arranged in a helix; practice should be distributed rather than massed.
10. The curriculum should make use of manipulatives, including calculators.
11. The curriculum should include practical routines to help build the arithmetic skills and quick responses that are essential in a problem rich environment.

METHODS

Introduction

The research question to be answered is did distributed practice result the growth of our first grade students as measured by district and classroom assessments. For the purpose of this study one-minute speed tests over twenty-five addition facts up to twelve were administered. There was also an interview given to twenty of the first grade students. This interview consisted of ten addition and subtraction problems. Data was also collected from the first grade teachers pre-post chapter assessments on the math curriculum taught over

a four month period. This data was charted and analyzed.

Setting

Jewett Elementary school is located in Evansdale, Iowa. The school population is 450 students. The community population is 4,520 people. First grade at Jewett Elementary has 67 students with three sections. These three sections are populated with twenty to twenty-two students in each section. There are eleven Bosnian students at this grade level, twelve Spanish students, one Vietnamese, one African American, and forty-two white English speaking students.

Participants

Students

There are three of sets participants in this study. Two sets of the participants in this study were the same. The participants used in two of the measures were twenty first grade students from the same classroom: four Bosnian, two Spanish, and thirteen white students at Jewett Elementary. The participants used for the third measure were all three sections of first grade at Jewett Elementary, including eleven Bosnian, twelve Spanish, one African American, one Vietnams, and forty-two white English speaking students.

Measurements/Instruments

One-Minute Speed Test

The first measurement in this study was one-minute speed test. The one-minute speed tests consisted of 25 addition questions up to twelve. This measurement was graded by percentage. Percent was figured by the

number missed out of twenty-five. Proficiency was set at eighty percent by classroom teacher. The purpose of this assessment is to see if there was an increase in accuracy and number of problems answered. This would indicate whether students were improving in addition facts. The limitation to this measurement is that it only assesses basic facts and does not require any mathematical problem solving strategies nor does it require the student to show how they came up with the answer.

Interview

The second measure in this study was an interview about word problems developed by Dr. Rathmell at the University of Iowa. The purpose of this interview was to see what strategies, representations, and math language the students were using. The limitations of this measurement is that not all of the strategies had been introduced to the students so some were not used. Another limitation is interview was conducted at the beginning of the year, and any significant trends may not emerge until the end of the year.

This measurement will contribute to the study to show what strategies the students are learning, and which ones are most useful and effective to them when solving math problems. This measurement consisted of ten addition and subtraction problems. The students were given the interview by the classroom teacher on a one to one basis. They were asked to solve the problem by using a choice of strategies, such as using doubles, making ten, count on, or count back. Along with this, the students were supplied paper, pencil, and maninpulatives to aid them in solving the problems. While students worked, the teacher monitored the math language students used when explaining how they solved the problem. As they worked through the

problem, the classroom teacher charted the strategy that best fit what they were doing, what representation they choose to aid them in solving the problem, and the language they used on the interview sheet. (See Appendix B under August and November for strategies used, representation, and math language used.)

Fluency Worksheet

The third measurement used in this study was the fluency worksheet also developed by Dr. Rathmel at the University of Iowa. (See Appendix C.) The purpose for the worksheet was to record the specific strategies the students used fluently. This measurement will identify whether the strategies taught in class were actually being used. The fluency worksheet consisted of nine addition and subtraction problems. The task for the students was to solve the problem by using specific strategies that the classroom teacher asked them to use. Some students were not familiar with the strategy or the name of the strategy. If the students used a strategy other than the one they were instructed to use the teacher noted this and discussed it with the students after the problem was solved.

Chapter Assessment and Basic Facts Data

The fourth measure in this study was the collection of data over the chapter assessments in first grade. The purpose for this measurement is to see what number of first grade students at Jewett Elementary are proficient on the math curriculum chapter assessments given in the 2004-2005 school year. These assessments were the first four math tests administered. Each teacher gave a pre and post on each chapter taught. These assessments were measured by percent correct. The proficient percent was eighty and non-proficient was below eighty. These levels of proficiency were determined by

the district. The limitations of this measurement is that we only have this years scores to examine, so trends will not emerge for a year or two. This measure will contribute to this study to tell us the number of proficient students on the math curriculum chapter assessments. This measure required data collected from all three first grade teachers on all pre/post chapter assessments. (See Appendix D.) This data was then analyzed and charted.

Procedure

One-Minute Speed Test

In August the students were given a one-minute test that had twenty-five addition problems in a whole group setting. This same one-minute test was given again in late October and again in November. This assessment will continue throughout the year at these same intervals. This data will be collected by the classroom teacher and graded by percent of answers right out of twenty-five then charted to see if there is an increase in accuracy by percent and number of problems that was answered. (See Appendix A.) Proficiency level was eighty percent.

Interview

Students were also given an interview over ten addition and subtraction word problems in August and late November on a one to one basis. The problems were read to the students by the classroom teacher, and students were offered manipulatives to use. The responses for each student were coded on a strategy data recording sheet. (See Appendix B.) This information was then broken down into three categories: strategies,

representations, and math language. Within each category were five to six sub groups in which the teacher coded the students primary strategy, representation, and math language used to solve the problem. This information was then tallied according to the specific sub group each student used under strategies, representations, and math language. When interviewing the students in August and November, they were given the option of skipping problems that were too difficult to answer. This is an important piece of information when looking at the column graphs that shows data in strategies used, representations, and math language (See August and November in Appendix B). This data changes from student to student and from category to category.

Fluency Worksheet

A fluency worksheet was administered. (See Appendix C.) On this fluency worksheet students were asked to solve the problem by using specific strategies told to them by the classroom teacher such as "counting on," "doubles make ten," "counting back," "counting up," and "use ten." As they responded, the teacher wrote their answer down and the amount of time it took to solve the problem by using these specific strategies. If they used a strategy that differed from the teacher's instruction, but was one of the strategies on the fluency worksheet, then it was circled based on which strategy it most closely resembled.

Math Assessments and Basic Facts Data

All math data was from the three first grades teachers. This data consisted of all first grade student's pre and post scores over the first four chapter assessments from the new math curriculum. This data was then charted

on a graph by chapters to see how many students in first grade are proficient and the gains made from pre and post. (See Pre/Post for chapters one to seven in Appendix D). This data was then totaled with all the students scores to determine how many students were actually tested, how many were proficient, and how many were not proficient. These numbers were then calculated to the percent. (See Appendix D).

Teaching Method

This intervention specifically will analyze the student's fluency in use of their math strategies, monitoring their growth in basic facts skills, and how proficient the students are as measured by classroom assessments and district assessments. The intervention is distributed practice in math. The procedure of daily-distributed practice is using problem solving strategies focusing on addition. Each day a word problem is posed to solve from the *Thinking with Numbers Cards* along with questions developed by Dr. Rathmell. These questions help the students to learn partitions, learn how to efficiently count on, to add, and to efficiently count back and count up to subtract. This gives the students an opportunity to think about the problem and then to share how they came to the mathematical answer. The student's thinking strategy is then highlighted by repeating the strategy and using manipulatives to concretely model the student's solution to the math problem.

RESULTS

Introduction

The analysis of all the data indicates that the students did show growth in problem solving strategies in addition. There is an increase of the number of addition facts answered correctly and facts answered as measured in the classroom assessments. This growth can be attributed to distributed practice. There is also an increase in a large population of the percent of students proficient from pre to post assessments in all three sections of first grade on the new math curriculum. This study also shows an overall increase for the entire first grade when students were combined on chapter assessments.

One-Minute Speed Test

The data collected and graphed on the speed tests show all students increased in the percent of problems answered correctly from the pre test at the beginning of the year to the most recent assessment given in November. (See Figure 1 on following page and the Speed Test Data for November in Appendix A.) The pre-test given at the beginning of the year shows that only six students scored below ten percent and fourteen students scored zero percent. In October, four students scored below twenty percent. Eleven students scored above twenty percent but no higher than sixty percent and five students scored zero percent. (See Appendix A for the Speed Test Data in October.) In November, there were three students that scored below twenty percent. Thirteen students scored above twenty percent but no higher than

sixty percent and three students scored above sixty percent with one student scoring a hundred percent. (See the Speed Test Data for November in Appendix A.) This shows a steady increase with four students at the proficiency level of eighty percent. This data also shows there was a steady increase in the accuracy of the students one-minute timed tests at all intervals. The data also shows on the column graph an increase of the number of problems that the students answered in the one-minute time. (See the Speed Test Data for October in Appendix A.) On the pre-test only six students were able to answer an average of two or three. In October, eighteen students answered between three to sixteen problems, and in November, all twenty students answered one to twenty-five problems. (See Figure 2 and Appendix A.)

Interview

Data collected on the interview also showed growth in the three categories strategies, representations, and math language . In the column graphs strategies used the dominant strategy used was counting on with counting all next. (See August in Appendix B.) The dominant use of these strategies could be because in chapter one we focused on counting on and counting all to solve math problems. For questions one through five the third most used strategy was "count back." Questions six through ten known facts and other various strategies were used. There is also a decrease in the amount of students that answered from question seven through ten, probably because the problems becoming more difficult. If students did not know how to answer, they were given the choice to skip it. The count all and count on strategies were frequently used to solve problems one through eight. (See November in Appendix B.) There was also

an increase in using known facts strategy rather then counting back. This is because the students became fluent in recognizing math facts. There was also an increase in the amount of students answering the questions from one to ten. (See the assessments of strategies for August in Appendix B.)

On the pie graph a little over half the class was using the counting on strategy. (See Appendix B .) On the pie graph the students were beginning to use other strategies such as count back, known facts, and other strategies that they may have acquired since the beginning of the year. (See Appendix B for strategies used in November.) This shows that students are learning different skills to solve their mathematical problems.

Data collected in the second category representation column graph shows fingers and counters as the primary representation used to solve problems. (See Appendix B for the August assessment of representations.) This was a common way to solve a math problem at the beginning of the year. There is also a decline in the number of students that answered questions and weather the student could solve it. On the column graph for there is a big decrease in fingers and an increase in using mental representations. (See Appendix B for November assessments.) There is also a slight increase in drawing a picture. This is due to the students becoming more fluent with basic facts and mentally thinking about problems in their head . There is also a large increase in the amount of students that answered questions one through ten. This is due to their confidence in math and their thinking skills.

When looking at the pie graphs, the main representations in August were fingers and counters. (See Appendix B.) In November, the mental

representations were almost used by half of the class along with fingers and counters, a decrease from August. Again this is due to the students' capabilities to figure math problems mentally instead of using fingers as a strategy.

In the third category of math language, the column graph for shows the most popular term as "add" with the other being "take away." (See Appendix B.) In the column graph for a variety of terms were used when the students communicated what they did in the word problems. This again shows an increase, due to the new language and vocabulary that they were exposed to from August to November. Here again we also see the number of students that answered the questions from one to ten increased from month to month, although there was still a decrease from number five to ten due to difficulty of the problem and the students uncertainty about how to solve the problem. When looking at the pie graphs for we can see that August shows two dominant terms "take away" and "add." (See Appendix B.) In November the terms "minus," "take away," "plus," and "add" is the main language in math. This shows an increase in the students understanding of the method and what it means to do when working through the problem.

Fluency Worksheet

The fluency worksheet provides a complete assessment summary on how fluent the teacher felt this student was at solving problems by using these specific strategies. (See Appendix C.) The fluency worksheet allowed the teacher to see just what each student knew about each strategy they used and if they knew how to use a specific strategy to help them to solve problems. If the students did not use the strategy, the teacher asked them what strategy they were using. If it was a strategy on the fluency worksheet, but not the one asked

of them to use, it was then coded under the one that best fit. This revealed whether the student knew a strategy and how to use it but did not know the name of it. This allowed the classroom teacher to build her instruction in those areas that the students needed additional instruction and direction. This summary was useful to the curriculum and focus for future math lessons. This information tells the teacher more work on thinking skills and building their confidence with drills and practice would benefit students.

Chapter Assessments and Basic Facts Data

The data collected on the chapter assessments were from August of 2004 to January of 2005. Chapters one, two, three, and seven were analyzed. The district did require first grade to teach these specific chapters in this order. Proficiency level is eighty-percent on all assessments; this is set by the district. When analyzing these chapters, twenty-percent was chosen as the cut off because students who were non-proficient on the pre-test came either very close to twenty percent or just above twenty percent. On all four chapters we can see a considerable increase between pre and post scores. In chapter one, the data indicates that thirty-five students were at proficiency level and twenty-eight students were below.

When looking at the gains between pre and post for chapter one there were thirty-eight students at or below twenty percent . On the pre and on the post there were only five students remaining that did not proceed past the twenty-percent mark. This tells us that all students made a significant gain but five. (See Appendix D.)

On chapter two the data shows forty-five students were proficient and

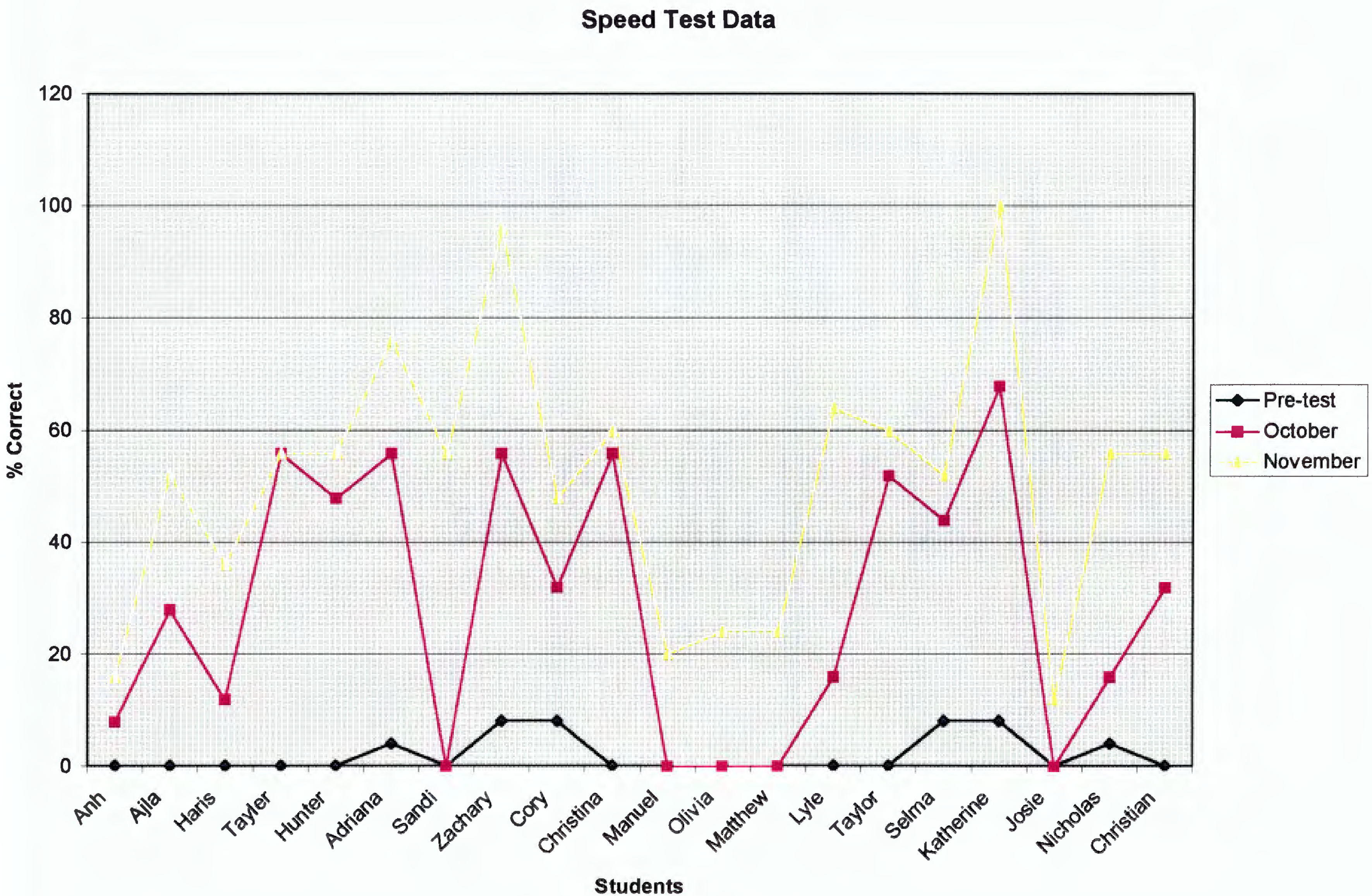
Speed Test Data
% Correct
120
100
80
60
40
20
0
Anh
Ajla
Haris
Tayler
Hunter
Adriana
Sandi
Zachary
Cory
Christina
Manuel
Olivia
Matthew
Lyle
Taylor
Selma
Katherine
Josie
Nicholas
Christian
Students
Pre-test
October
November

Table 1.1
Chapter Assessments

Teachers	# Proficient	Chapter # Non-Proficient	One % Proficient	# took assessments
Even	11	10	52%	21
Sires	11	9	55%	20
Traner	13	9	59%	22

Table 2.2
Chapter Assessment

Teacher	# Proficient	Chapter # Non-Proficient	Two % Proficient	# took assessments
Even	16	5	76%	21
Sires	17	2	85%	20
Trainer	12	10	55%	22

Table 3.3
Chapter Assessment

Teacher	# Proficient	Chapter # Non-Proficient	Three % Proficient	# took assessments
Even	17	5	77%	22
Sires	13	7	85%	20
Trainer	14	8	64%	22

Table 4.4
Chapter Assessment

Teacher	# Proficient	Chapter # Non-Proficient	Seven % Proficient	# took assessments
Even	13	9	59%	22
Sires	13	8	51%	21
Trainer	18	4	82%	22

eighteen were not proficient, which is an increase for the number of proficient and a decrease for the number of non-porficient when comparing chapters one and two. When looking at the gains between pre and post scores, there were only nine students that were at twenty percent or below, which is a big decrease from chapter one pre test. On the post test no students remained at or below twenty percent. This tells us all students made gains beyond twenty percent. (See Appendix D.) The significance of this is that there is a large gain in percent seen from pre and post scores on both chapters one and two. It also tells us those students had increased in percent from both pretest significantly from chapter one to chapter two. This evidence shows that students had previous knowledge in this area by the time chapter two was introduced and by building on their knowledge were able to add to what they already knew and apply it on the pre test. There was also evidence of these two chapters being closely related. Students were given the foundations needed to do the math. Then in chapter two, they applied these strategies and knowledge to solve problems.

When looking at chapter three, the data reveals forty-four students were at proficiency level and twenty students were not proficient. This is a one student difference in the number of proficient when comparing it with chapter two. It also shows a very slight increase in students that were not proficient from chapter two and three. The gains from pre to post for chapter three were higher in percent only five students were below twenty percent and forty students got sixty-percent on the pre test. This suggests that students are acquiring skills through daily distributed practice and being taught the right content they need to know in order to solve mathematical

problems. (See Appendix D.)

In chapter seven, forty-four were proficient and twenty-one were not proficient, which is the same amount of students that were proficient on chapter three. Non-proficient changed only by one less. Data also shows a dramatic decline in the gains on the pre-test scores, twenty-four were below twenty percent, which is a difference of six students when compared with chapter one pretest. When looking at the post scores, only six students were below sixty percent. This is a dramatic increase from pre to post in chapter. We did still see an increase in pre to post scores in chapter seven. (See Appendix D.)

In tables 1.1 to 4.4 each chapter is broken down among the three different teachers with the number of students that were proficient, and non-proficient. It is then totaled under each column for each teacher the total number of students that took the assessment, the number of proficient, and then last column represent the percent of only proficient students.

DISCUSSION

The research question to be answered is did distributed practice result in the growth of our first grade student as measured by district assessments classroom assessments?

One Minute Speed Test

The finding of the results of the speed test shows a steady increase in the accuracy and number of problems answered by the students at all intervals. In general all students showed growth. This indicates that everyday using problem solving strategies that focus on addition did increase students learning capabilities to effectively count on and to add accurately.

Interview

The purpose for the word problem interview was to reveal the students thinking skills. The skills identified were strategies the students used, representations (such as pictures and manipulatives), and math language. The results of this interview show that there was a growth from August to November's interview in the amount of information the students knew in all three skills evaluated. In the strategies used there was an increase in three specific strategies which were count all, count on, and known facts strategy. This means that as daily-distributed math was delivered effectively. Focusing on strategies to solve math problems, giving students an opportunity to think about the problem, then sharing how they came up with the solution, and highlighting their thinking strategy had a definite impact in their knowledge of strategies and learning different skills to solve

mathematical problems as supported by the survey. Findings from the two interviews also indicated that the number of problems answered by each student increased. This is significant because students not only are acquiring the skills needed to solve these problems but are raising their confidence level.

In the second category , there was also a growth from August to November's interview. In August, the primary representations used were fingers and counters. The November interview findings show a decrease in fingers and an increase in mental representations. This can be aligned with distributed math by allowing students to think about a problem and mentally work through it in their head as the teacher concretely models the students thinking solution to them.

There was also an increase in the amount of students answering the question on the two surveys in this category too. This tells us those students may have been more easily able to picture the problem in their head and do the kind of thinking that the classroom teacher was promoting in this.

In the third category, math language also shows indications of growth from August to November's interview. The findings show that in August the most popular term was "add and take away." In November the terms "minus, take away, plus, and add" was the main language. These results mean that doing distributed math daily practice exposes students to new math vocabulary. Asking questions orally, requiring students to explain solution, and then listening to the teacher repeat the strategy back to the student the strategy embedded embeds students within the mathematical vocabulary.

Fluency Worksheet

The fluency worksheet allowed me to see what each student knew,

and if they knew the application to solve the problems when given a specific strategy. The findings of this data allowed me to see what strategy were they using. And whether they were using it correctly. In turn, I can apply this information for future lesson plans and curriculum. This measurement cannot allow for any trends of improvement to be identified until the end of the year, although the students are showing an increase in fluency and can apply the strategies they are learning.

Chapter Assessments

The data collected on the chapter assessments shows an increase of non-proficient students from chapter three to seven along with a change in the curriculum. Chapter seven was devoted to teaching students hundreds, tens, and ones, while chapters one, two, and three were building on addition and concepts that need to be laid in order for one to learn these strategies and solve problems.

This study indicates an increase in our first grade students in math. These improvements come from distributed practice and the support it gives to our students understanding. More spaced time on specific curriculum is needed to help our students retain and learn the information. As this study suggests, teachers should be doing less over shorter periods of time rather than doing more over long periods of time. We need to make our discussions in our classrooms meaningful and helpful to students. Some students will need that small group instruction verses large. It is our responsibility as teachers to know who these students are and what modifications they need to close the gap in their understanding.

The significance of these findings tell us we are moving in the right

direction, and the students understanding is building on what the teachers are doing in the classrooms at Jewett Elementary. This study also leads us to discover where our non-proficient students are and to pinpoint why these students are unable to meet the district standards. Perhaps we can increase our number of proficient students to a hundred percent so all can feel successful. This type of research also gives way to new approaches to teaching mathematics and gives teachers an effective practice to improve our scores at Jewett Elementary on achievement, ITBS, and district assessments.

Future Research

With the evidence of this study what is our next step to continue in the right direction? What factors have contributed to this increase at Jewett Elementary? Is distributed practice an effective practice alone or does other factors play important roles too? If there are other factors what are they and could we find them by more assessments, classroom analysis, and individual student strengths and weakness? Once this valuable information is found how could we implement changes needed in our classrooms and building? Do we need to reconstruct our objectives and methods of instruction to meet every students achievable capabilities?

Recommendations

As the study shows, distributed practice can have an impact on our students scores. This type of instruction should be implemented through out the school and district. Some steps in making this happen could be to attend teacher workshops, professional development, or contacting Dr. Rathmell from University of Northern Iowa to come

and discuss how we might as a school and faculty bring this distributed practice to all of the classrooms at Jewett Elementary.

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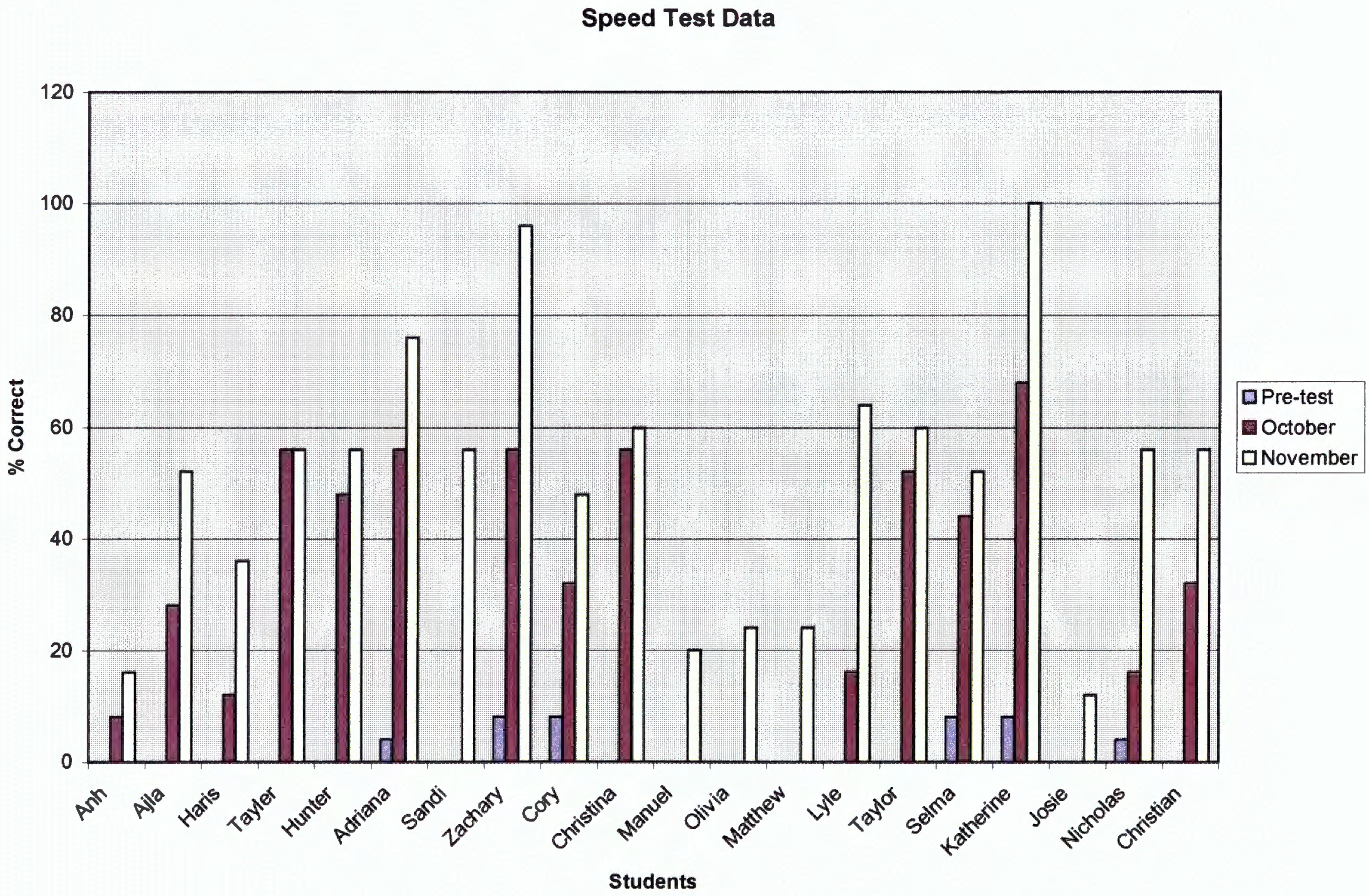
Appendices

Appendix A

POWER BUILDER 5	LESSONS 1–9

Basic Facts in Addition

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



Speed Test Data
120
100
80
60
40
20
0
% Correct
Pre-test
October
November
Anh
Ajla
Haris
Tayler
Hunter
Adriana
Sandi
Zachary
Cory
Christina
Manuel
Olivia
Matthew
Lyle
Taylor
Selma
Katherine
Josie
Nicholas
Christian
Students

Appendix B

1. John has 9 vedio games. He loaned 3 to Rachel. How many did he still have?

Answer	Time	strategies	representations	math lang.	Comment
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	
		Use known fact	mental	minus	
		Other	other	add	
				Other	

1. Kenny has $6. His mother gave him $2 more. How much money does Kenny have now?

Answer	Time	Strategies	Representations	Math Lang.	Comments
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	
		Use known fact	mental	minus	
		Other	other	add	
				Other	

2. Sarah has 4 green shirts and 5 blue shirts. How many shirts does she have in all?

Answer	Time	Strategies	Representations	Math Lang.	Comments
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	
		Use known fact	mental	minus	
		Other	other	add	
				Other	

3. Anne has 5 stickers. Tina has 8 stickers. How many more stickers does Tina have than Anne?

Answer	Time	Strategies	Representations	Math Lang.	Comments
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	
		Use known fact	mental	minus	
		Other	other	add	
				Other	

4. Eric put 10 fish in the school aquarium. Adam put in 7 fish. How many fish did the two put in the aquarium?

Answer	Time	Strategies	Representations	Math Lang.	Comments
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	
		Use a know fact	mental	minus	
		Other	other	add	
				Other	

5. Brad had 16 candy bars. He gave some to his friends. Now he only has 8 left. How many did he give away?

Answer	Time	Strategies	Representations	Math Lang.	Comments
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	
		Use a known fact	mental	minus	
		Other	other	add	
				Other	

6. Tara has a toy box with 24 dolls in it. She gets 10 more dolls and puts them in the box. How many dolls are in the box?

Answer	Time	Strategies	Representations	Math Lang.	Comments
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	
		Use known fact	mental	minus	
		Other	other	add	
				Other	

7. Tyler has 35 crayons. Allison has 32 crayons. How many fewer crayons does Allison have?

Answer	Time	Strategies	Representations	Math Lang.	Comments
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	
		Use known fact	mental	minus	
		Other	other	add	
				Other	

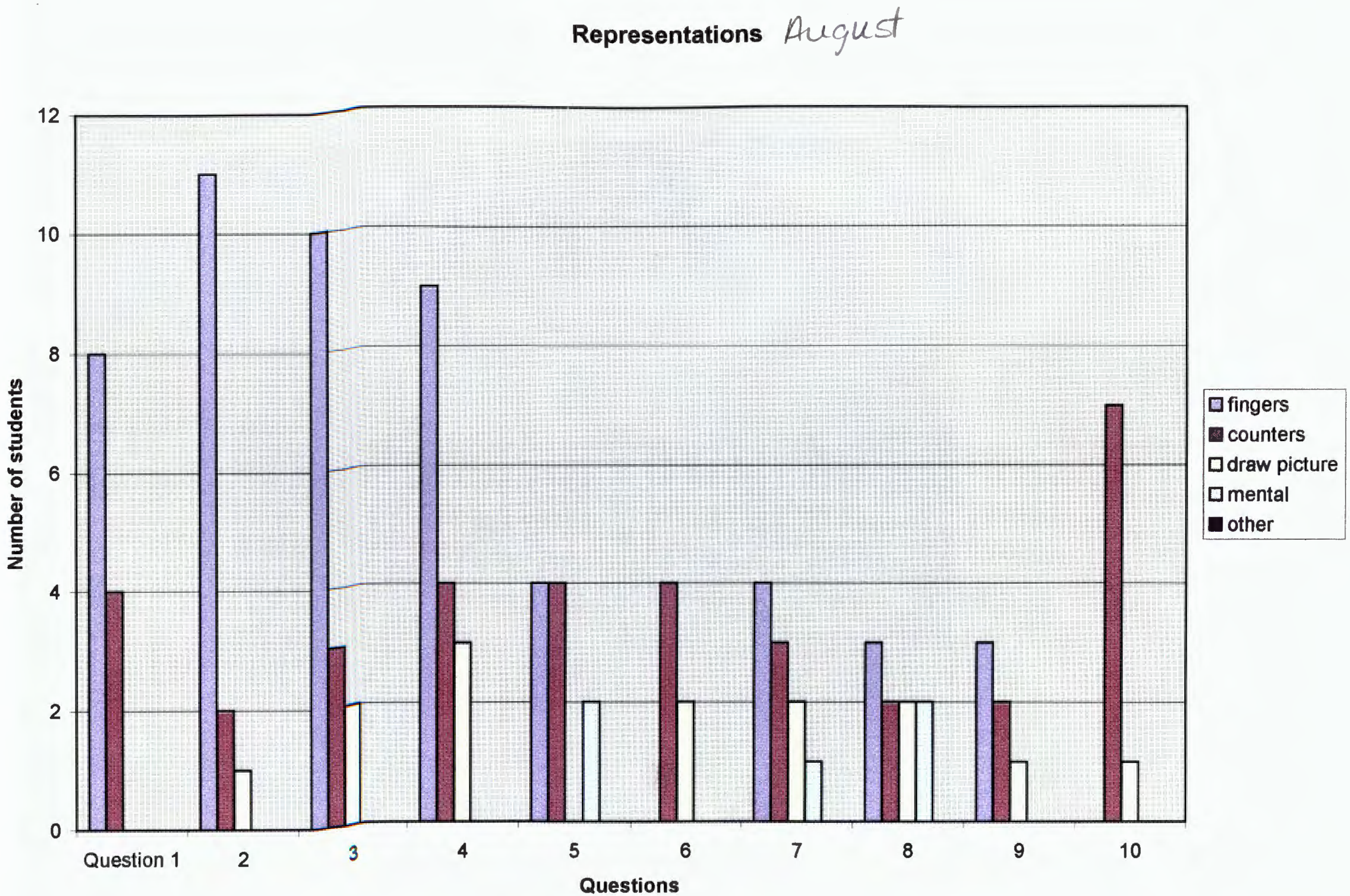
8. Ben and Matt each collected 26 aluminum cans. How many fewer cans did both boys collect?

Answer	Time	Strategies	Representations	Math Lang.	Comments
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw picture	plus	

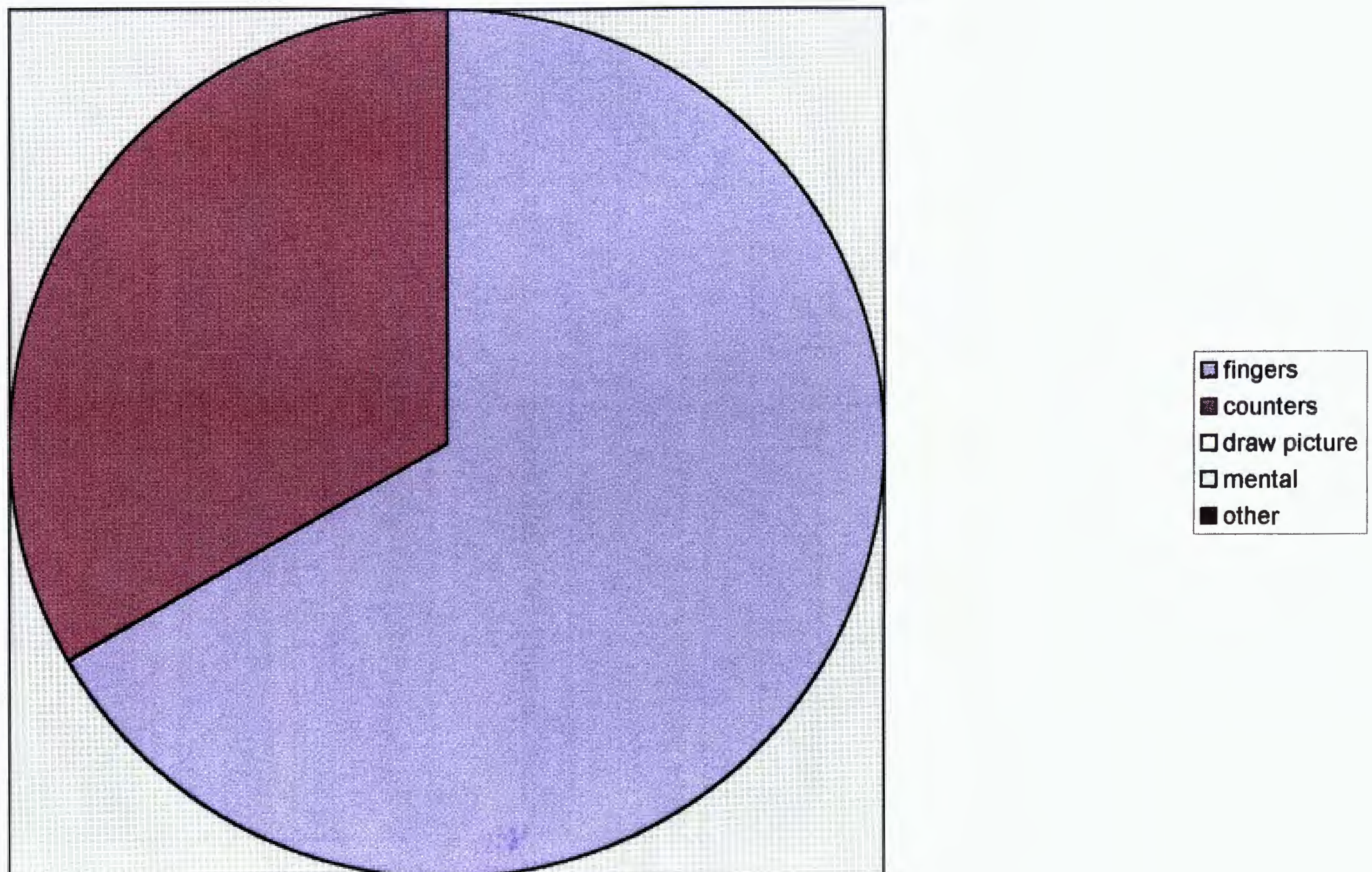
Use known fact	mental	minus
Other	other	add
		Other

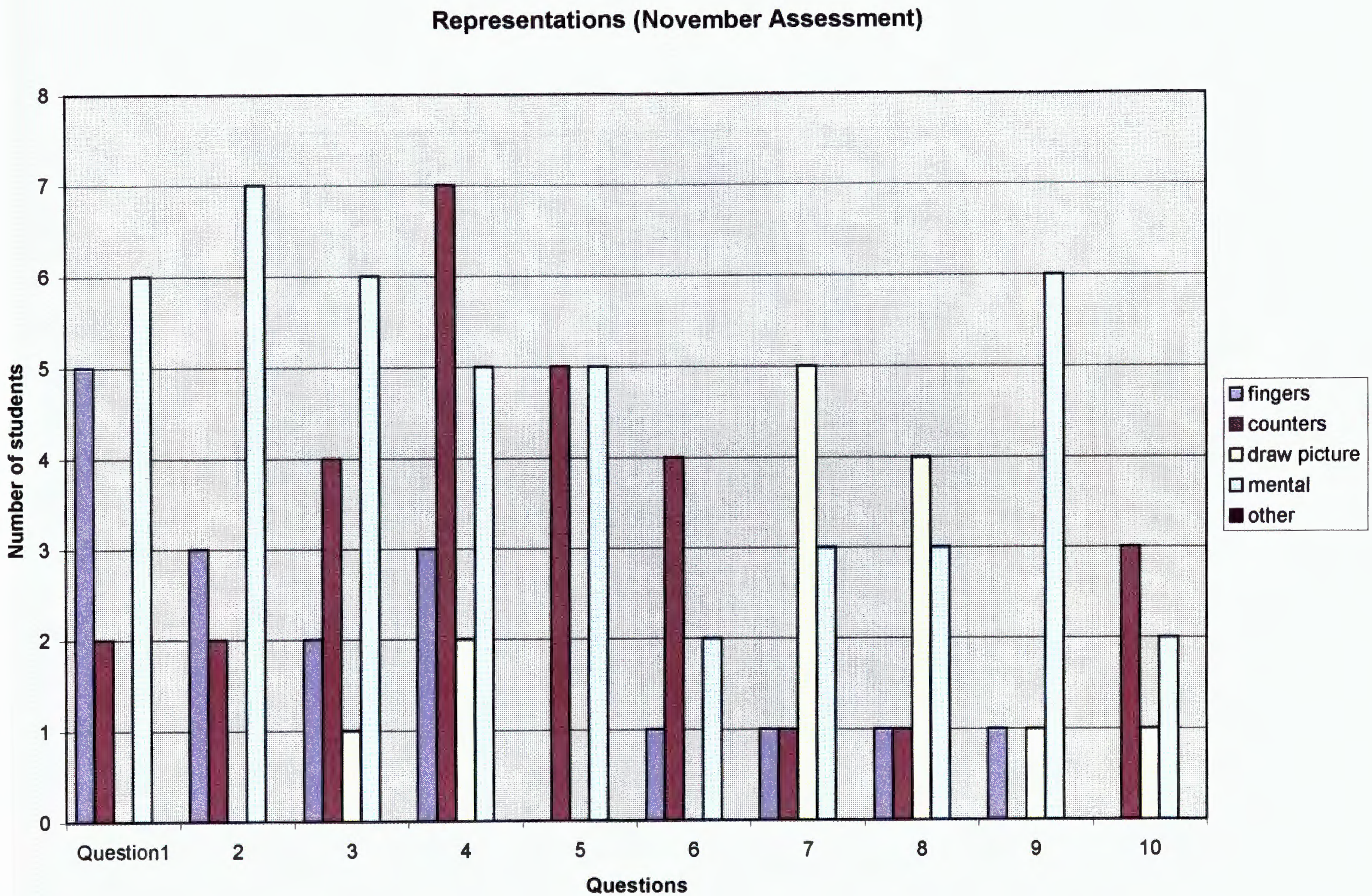
10. What is the total? 3+7+8+2=

Answer	**Time**	**Strategies**	**Representations**	**Math Lang.**	**Comments**
		Count all	fingers	join	
		Count on	counters	take away	
		Count back	draw pictures	plus	
		Use a known fact	mental	minus	
		Other	other	add	
				other	


Representations
August
12
10
8
6
4
2
0
Number of students
Question 1
2
3
4
5
6
7
8
9
10
Questions
fingers
counters
draw picture
mental
other

Representations August

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Number of students
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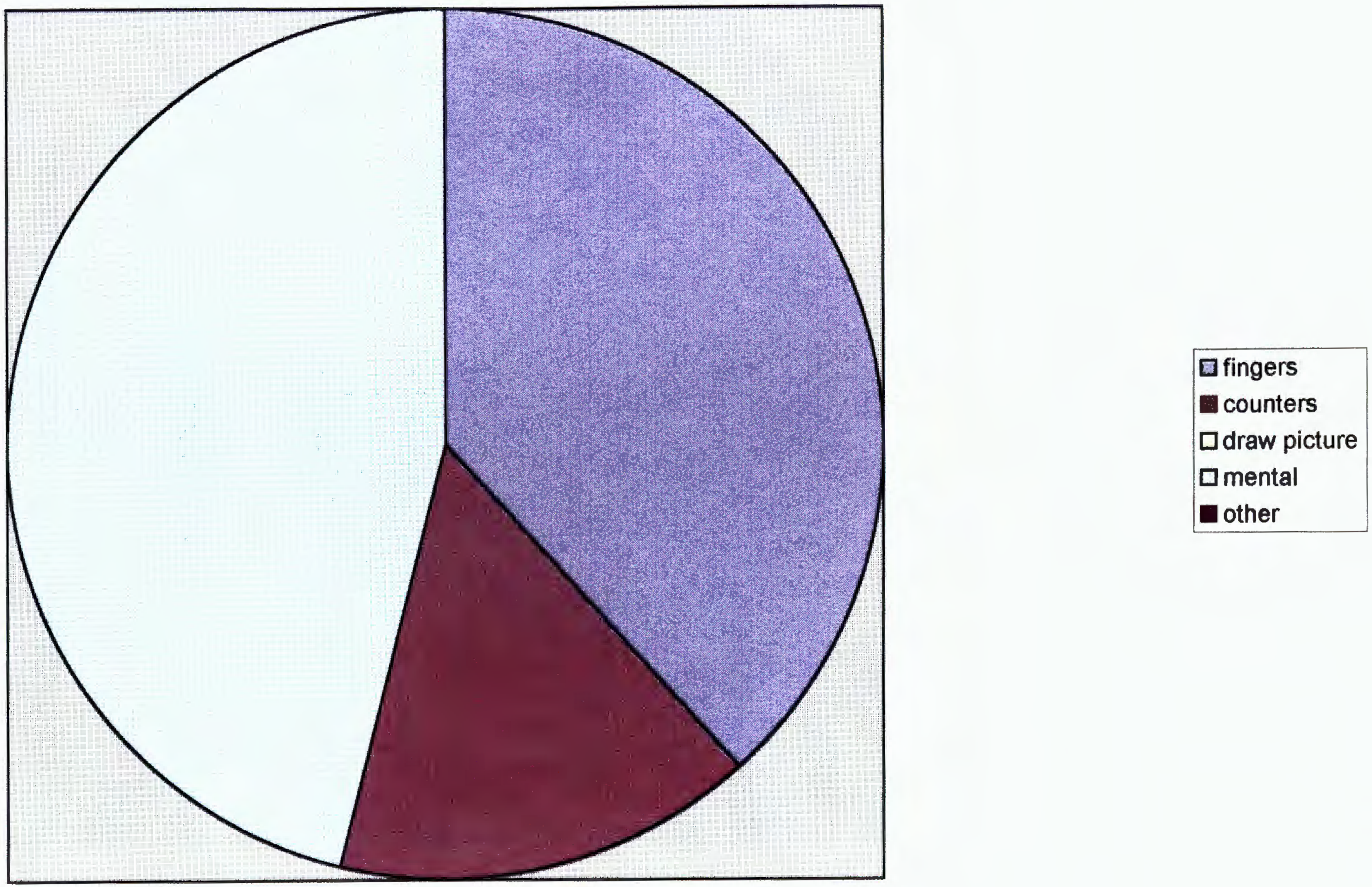
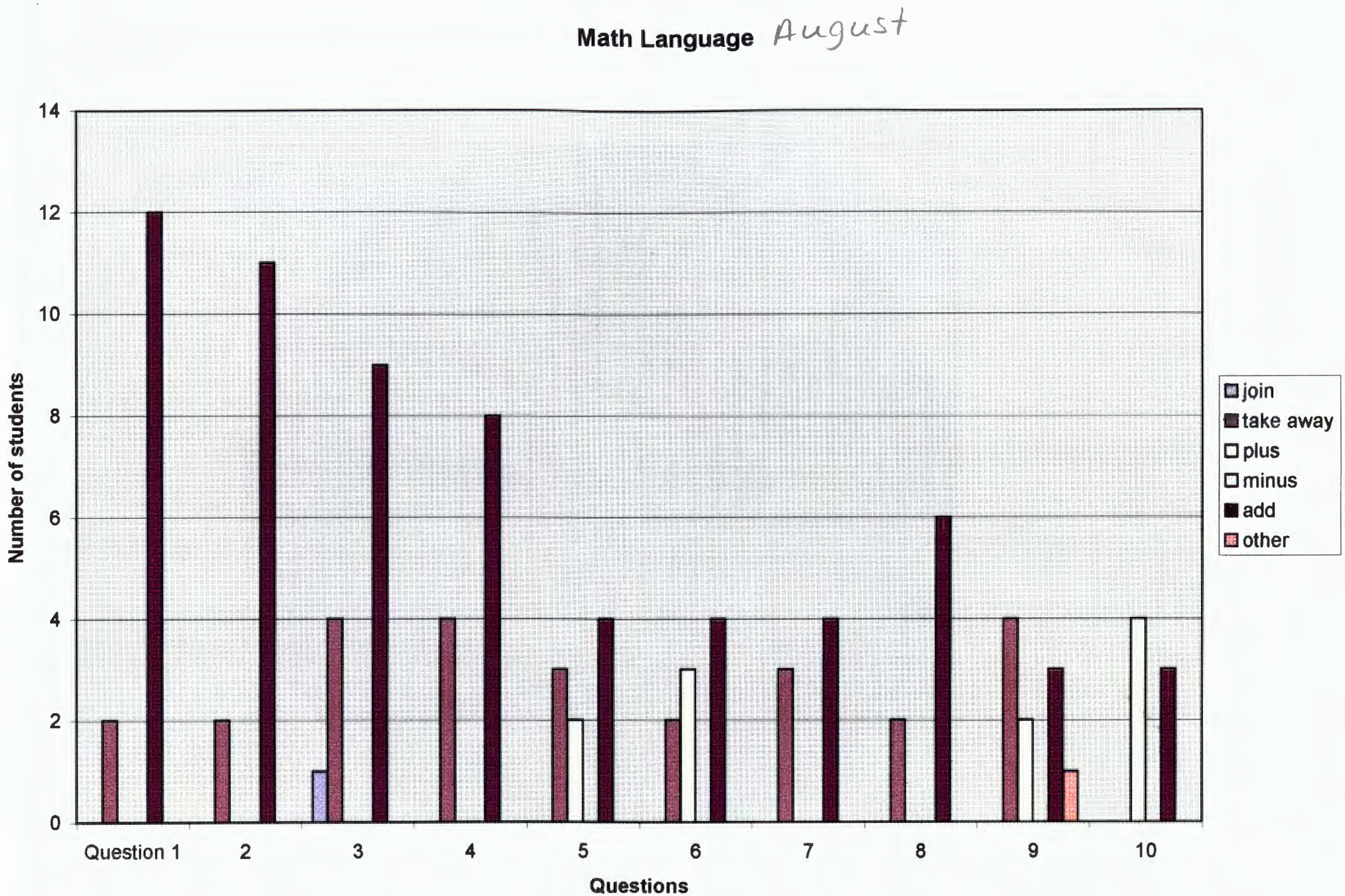
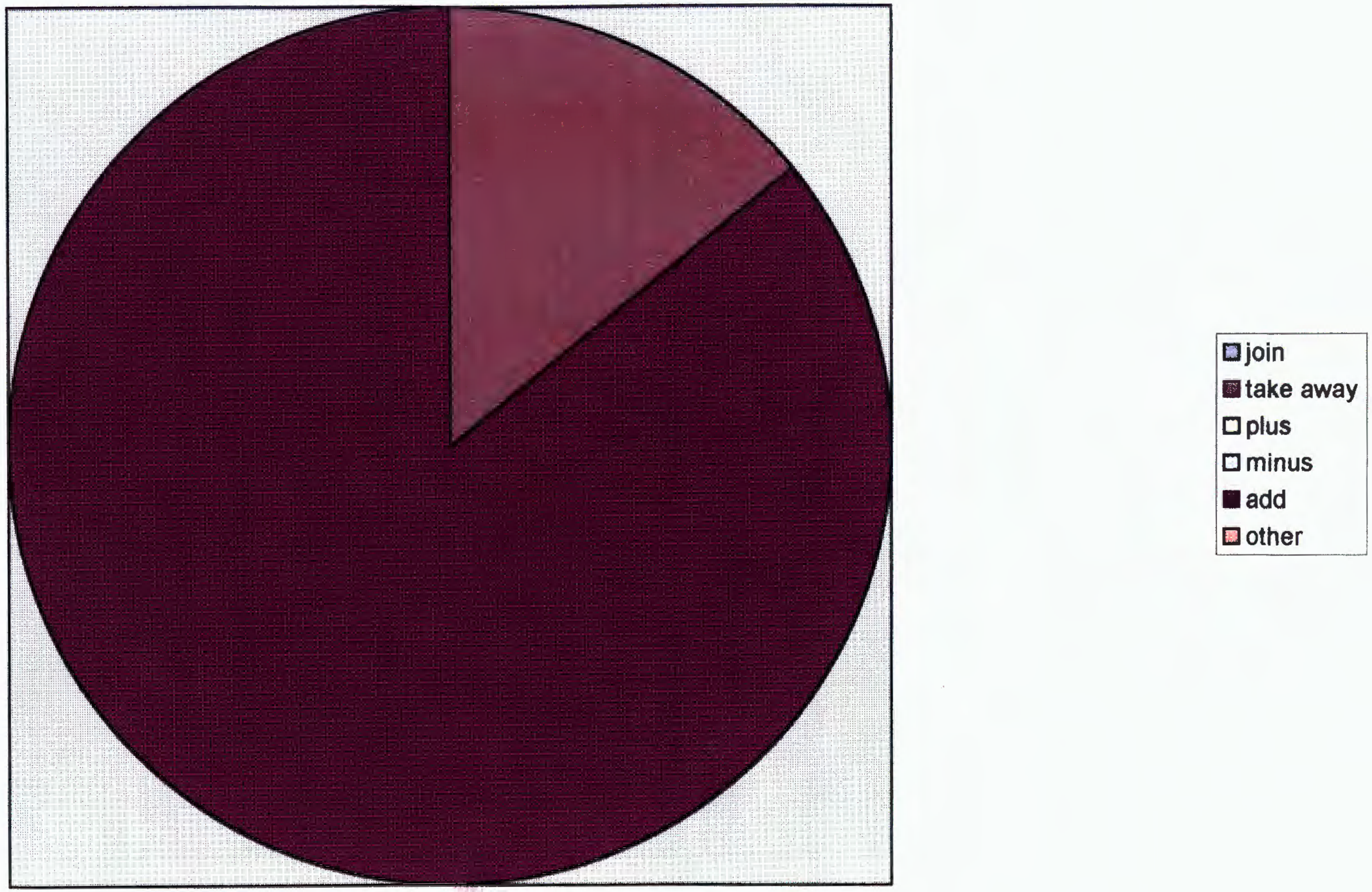
1
2
3
4
5
6
7
8
Question1
2
3
4
5
6
7
8
9
10
Questions
fingers
counters
draw picture
mental
other

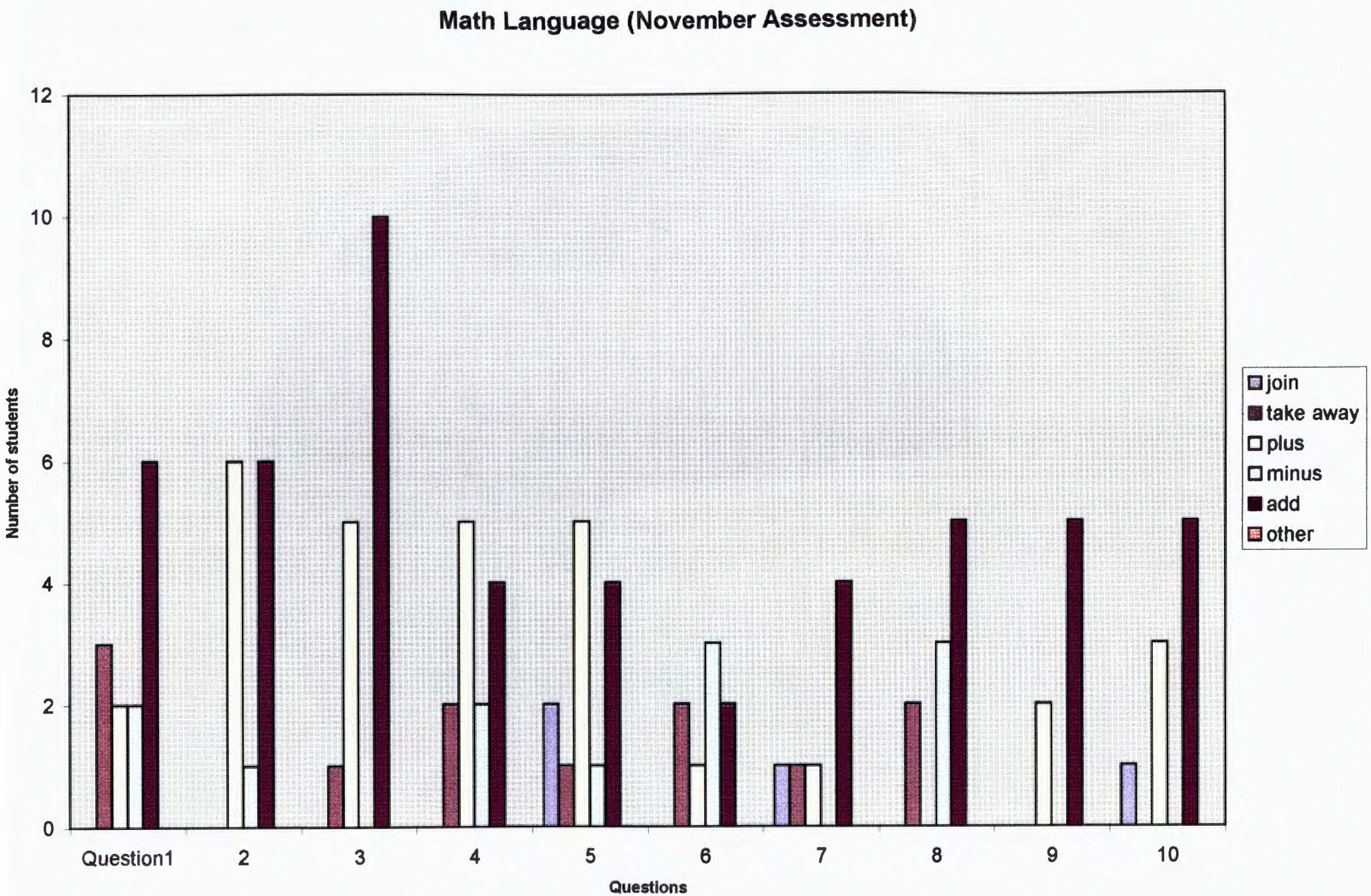
Representations (November Assessment)



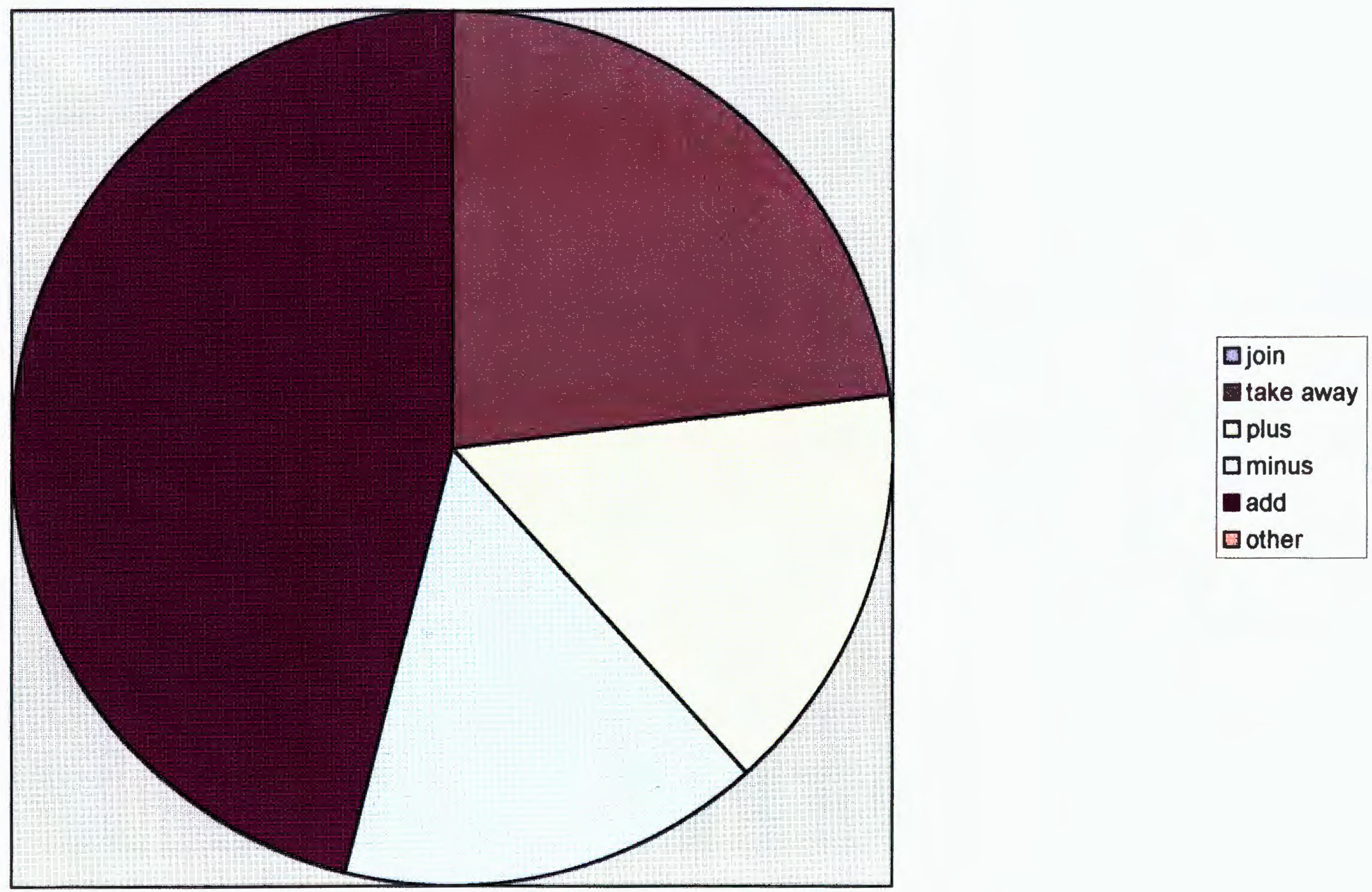

Math Language August
14
12
10
8
6
4
2
0
Number of students
Question 1
2
3
4
5
6
7
8
9
10
Questions
join
take away
plus
minus
add
other

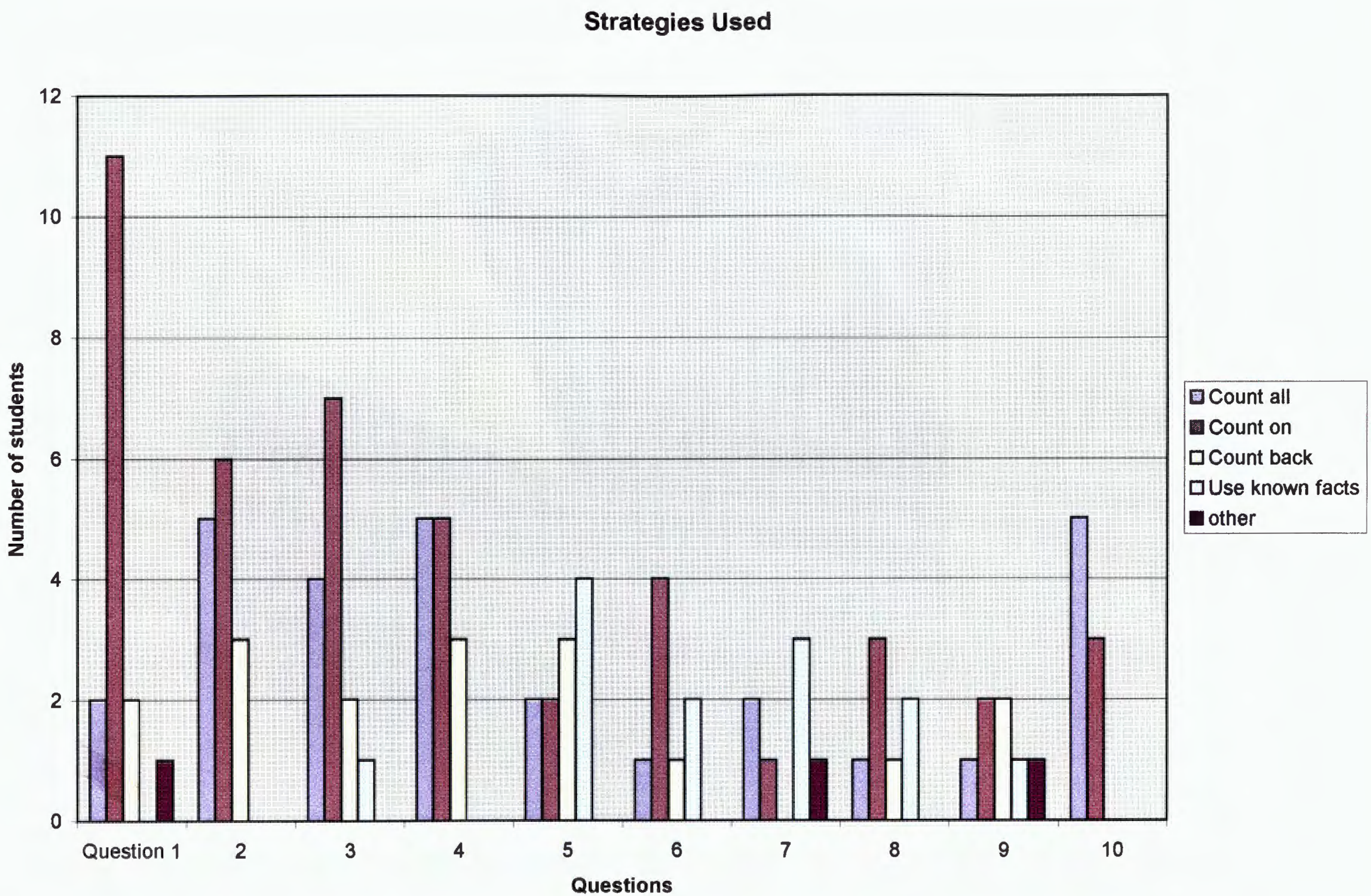
Math Language August




Math Language (November Assessment)
Number of students
12
10
8
6
4
2
0
Question1
2
3
4
5
6
7
8
9
10
Questions
join
take away
plus
minus
add
other

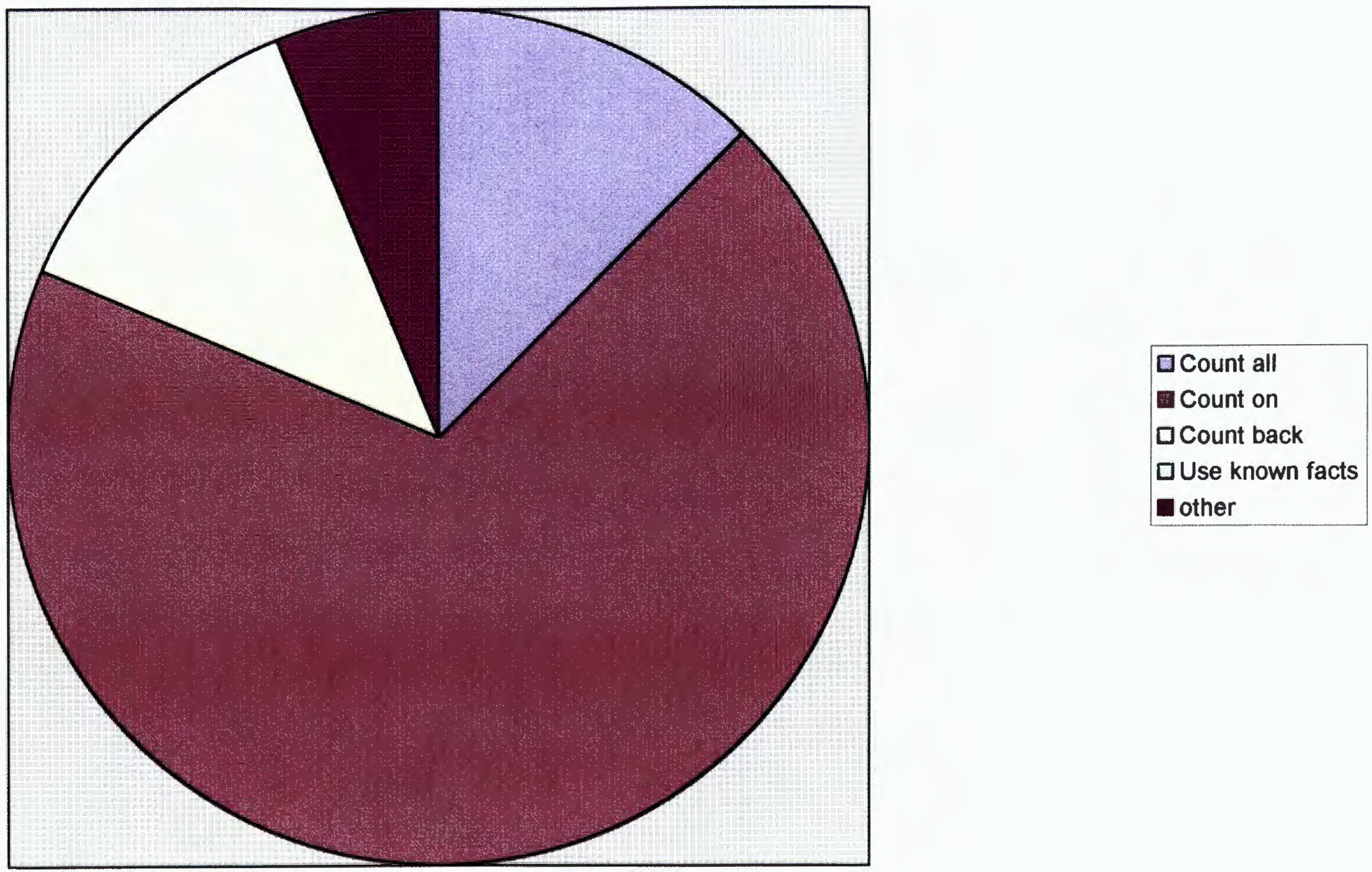
Math Language (November Assessment)





Strategies Used
Number of students
0
2
4
6
8
10
12
Question 1
2
3
4
5
6
7
8
9
10
Questions
Count all
Count on
Count back
Use known facts
other

Strategies Used



Appendix C

Identify the thinking strategies that were used during the interview for those only, ask the corresponding problems below to determine fluency with those strategies.

Have students use **count on** to solve the following, then mark the approximate number of seconds that it takes for the student to use this strategy.

6+2 3+7 9+2 Average time in seconds ______

Have the student use **doubles** to solve the following, then mark the approximate number of seconds that it takes for the student to use this strategy.

6+5 5+4 7+8 Average time in seconds ______

Have the student use **make ten** to solve the following, then mark the approximate number of seconds that it takes for the students to use this strategy.

9+5 8+4 7+9 Average time in seconds ______

Have the student use **count back** to solve the following, then mark the approximate number of seconds that it takes for the student to use this strategy.

6-2 7-1 10-2 Average time in seconds ______

Have the student use **count up** to solve the following then mark the approximate number of seconds that it takes for the student to use this strategy.

8-6 7-5 10-8 Average time in seconds ______

Have the students **use ten** to solve the following, then mark the approximate number of seconds that it takes for the student to use strategy.

12-8 14-5 15-9 Average time in seconds ______

Assessment Summary

Students Name ________________ Date______________ Grade_______

What strategies is the student currently using?

Addition: count all count on use known facts use tens

Subtraction: count all count back count up use known facts use tens

What strategies should the student be encouraged to use?

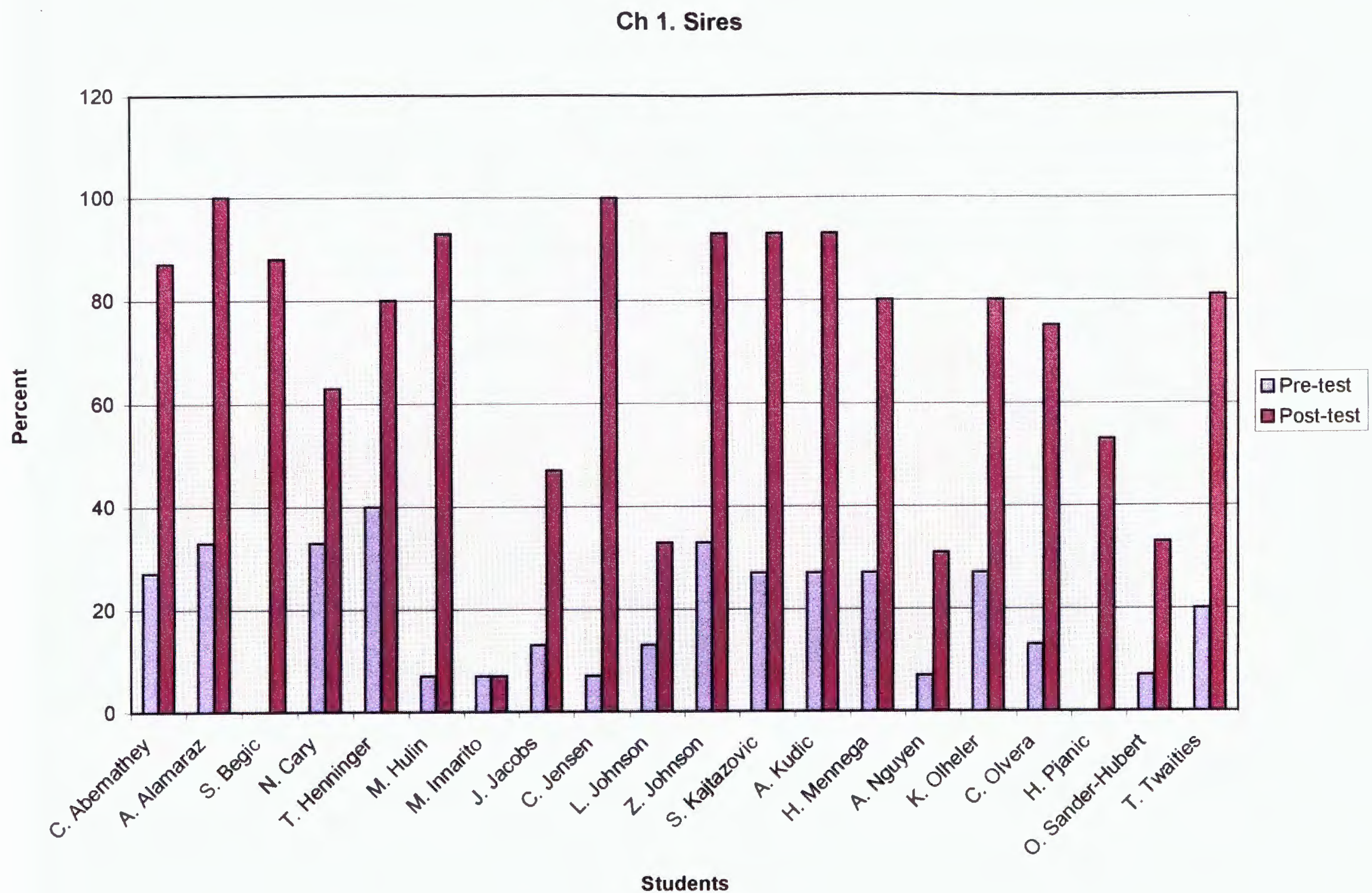
Addition: count all count on use known facts use tens

Subtraction: count all count back count up use known facts use tens

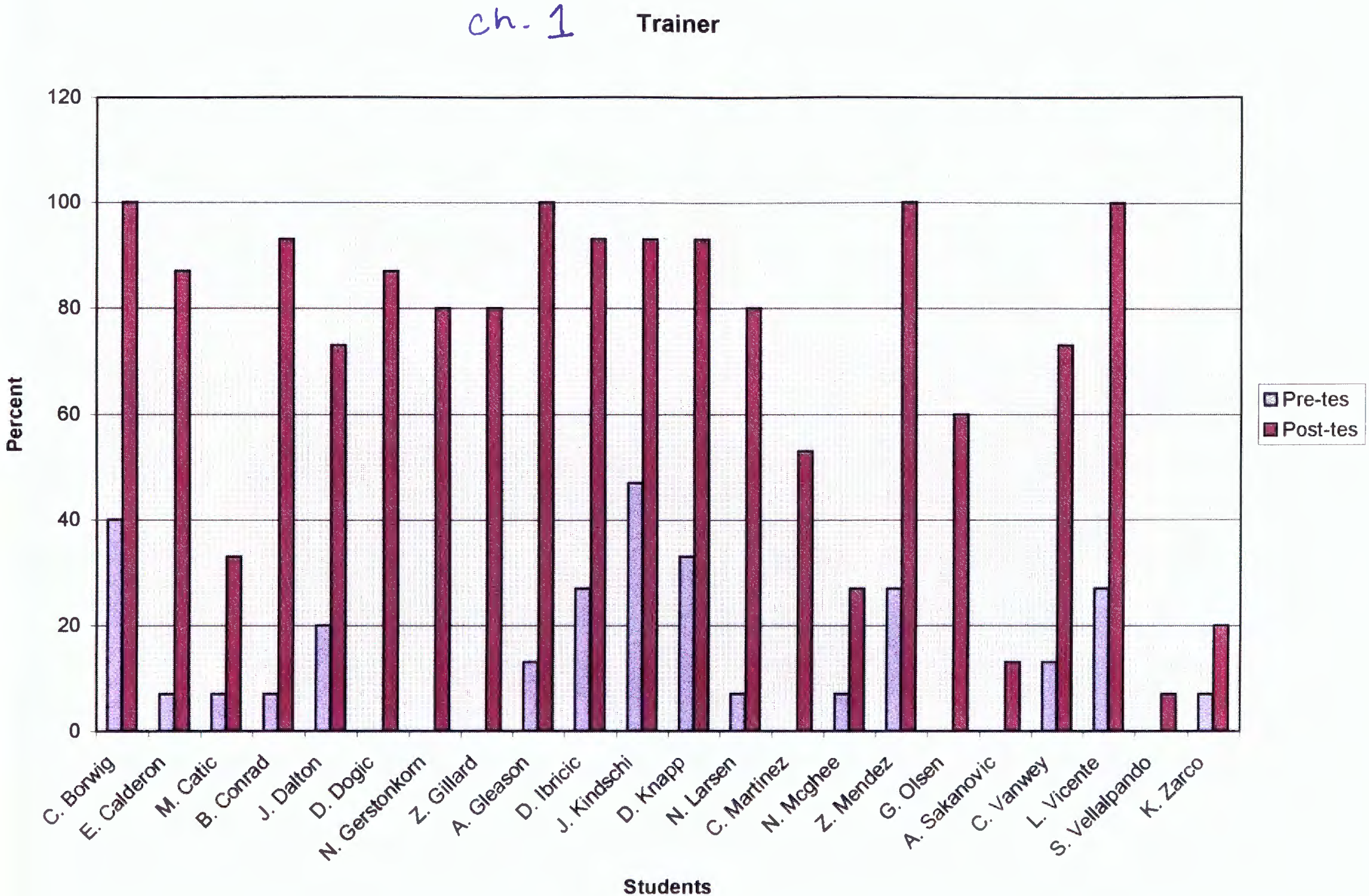
After completing the interview, use the following rubric to complete the following chart

Low	**developing**	**high**
Acts distracted Guesses	hesitates tries to make sense	responds quickly responds accurately Makes sense

	Low	**Developing**	**High**
Was the student confident?	____	________	____
Was the student's reasoning sound?	____	________	____
Were the student's expectations clear?	____	________	____
Did the student enjoy solving problems?	_____	________	_____


Ch 1. Sires
Percent
120
100
80
60
40
20
0
Pre-test
Post-test
C. Abemathey
A. Alamaraz
S. Begic
N. Cary
T. Henninger
M. Hulin
M. Innarito
J. Jacobs
C. Jensen
L. Johnson
Z. Johnson
S. Kajtazovic
A. Kudic
H. Mennega
A. Nguyen
K. Olheler
C. Olvera
H. Pjanic
O. Sander-Hubert
T. Twaities
Students

ch. 1


Trainer
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60
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Percent
C. Borwig
E. Calderon
M. Catic
B. Conrad
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D. Dogic
N. Gerstonkorn
Z. Gillard
A. Gleason
D. Ibricic
J. Kindschi
D. Knapp
N. Larsen
C. Martinez
N. Mcghee
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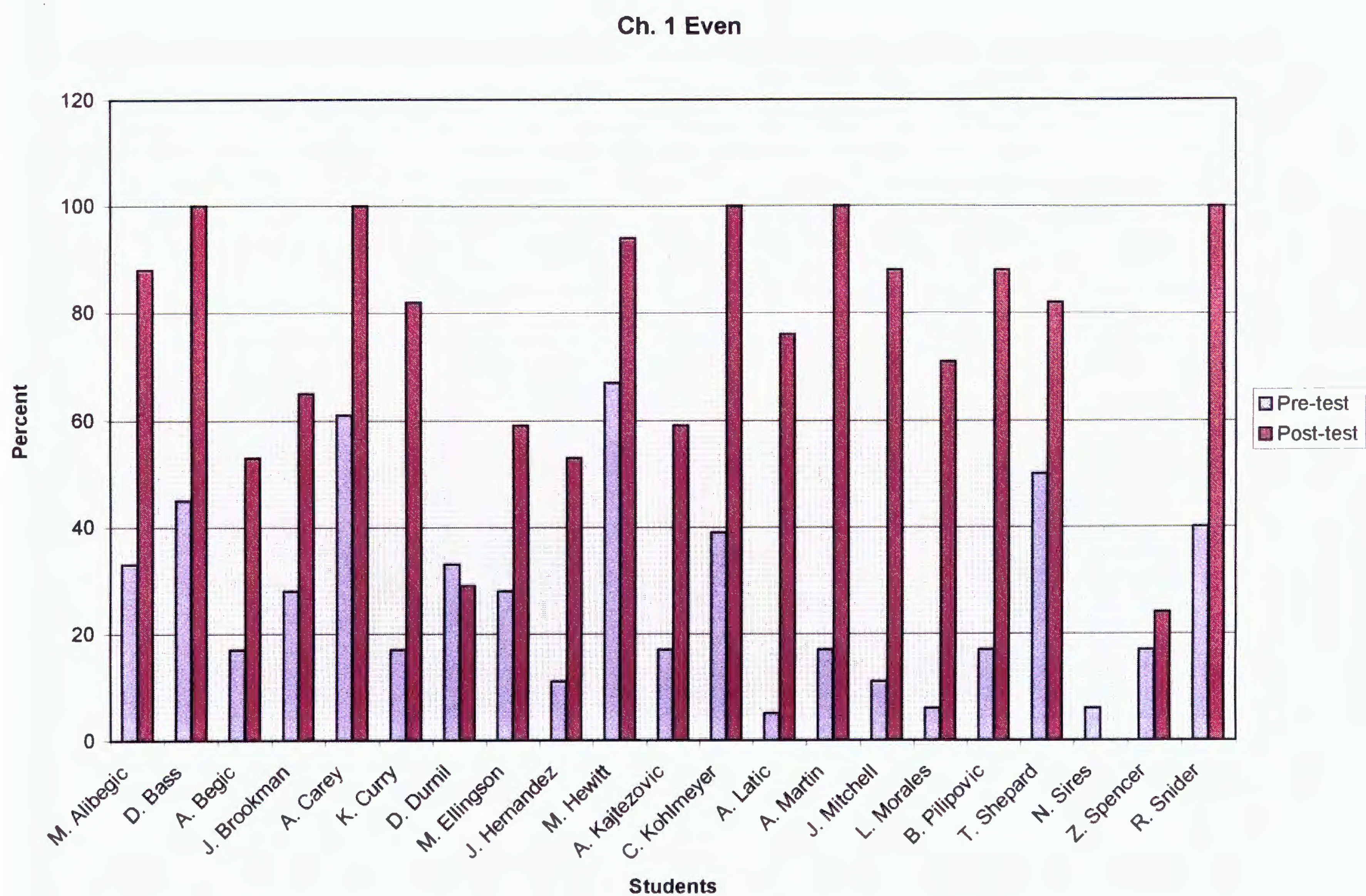
G. Olsen
A. Sakanovic
C. Vanwey
L. Vicente
S. Vellalpando
K. Zarco
Students
Pre-tes
Post-tes



Ch. 1 Even
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60
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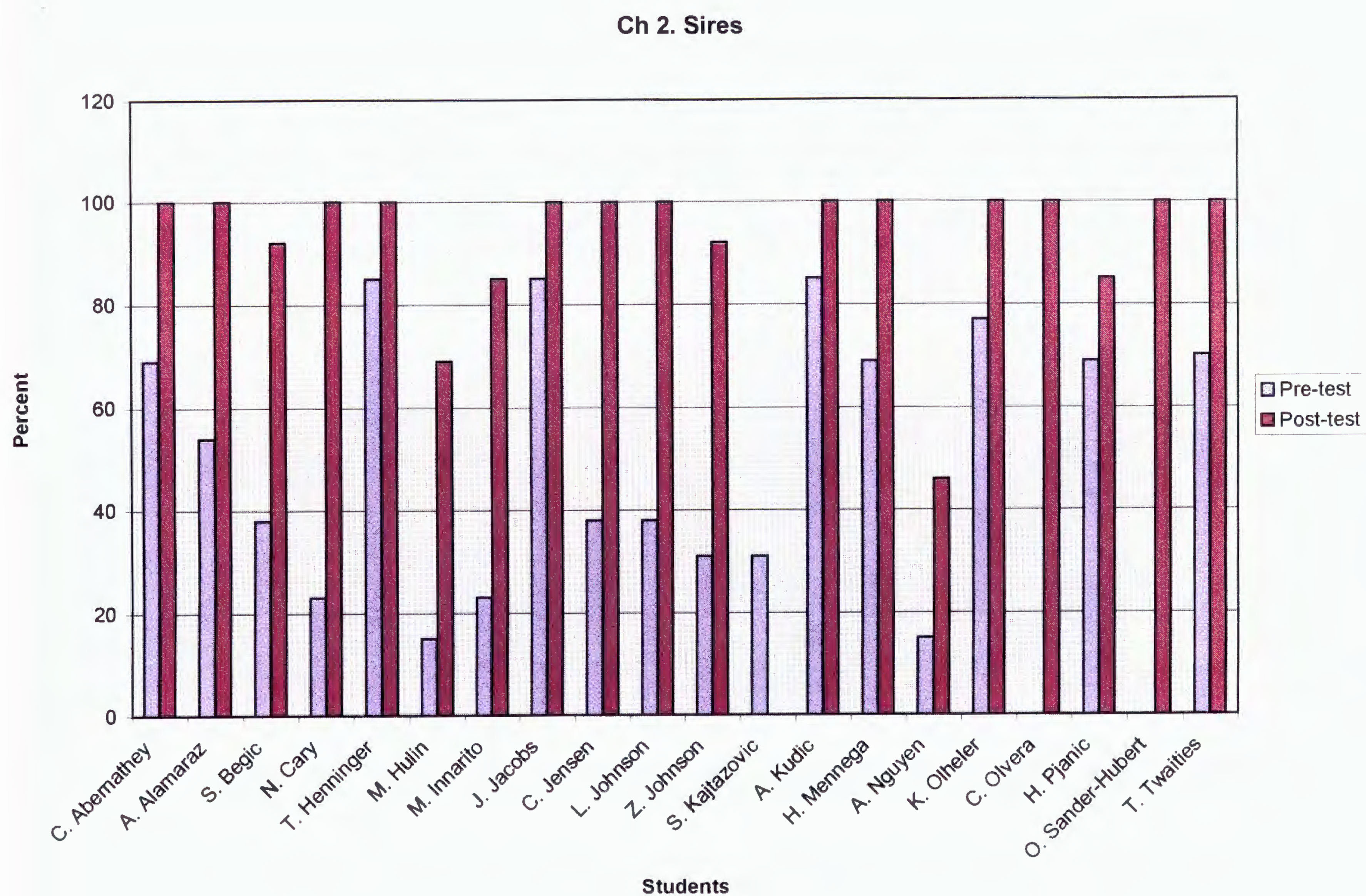
D. Durnil
M. Ellingson
J. Hernandez
M. Hewitt
A. Kajtezovic
C. Kohlmeyer
A. Latic
A. Martin
J. Mitchell
L. Morales
B. Pilipovic
T. Shepard
N. Sires
Z. Spencer
R. Snider
Students
Pre-test
Post-test



Ch 2. Sires
Percent
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100
80
60
40
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C. Jensen
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Z. Johnson
S. Kajtazovic
A. Kudic
H. Mennega
A. Nguyen
K. Olheler
C. Olvera
H. Pjanic
O. Sander-Hubert
T. Twaities
Students
Pre-test
Post-test


Ch. 2 Trainer
Percent
120
100
80
60
40
20
0
C. Borwig
E. Calderon
M. Catic
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D. Dogic
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Z. Gillard
A. Gleason
D. Ibricic
J. Kindschi
D. Knapp
N. Larsen
C. Martinez
N. Mcghee
Z. Mendez
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S. Vellalpando
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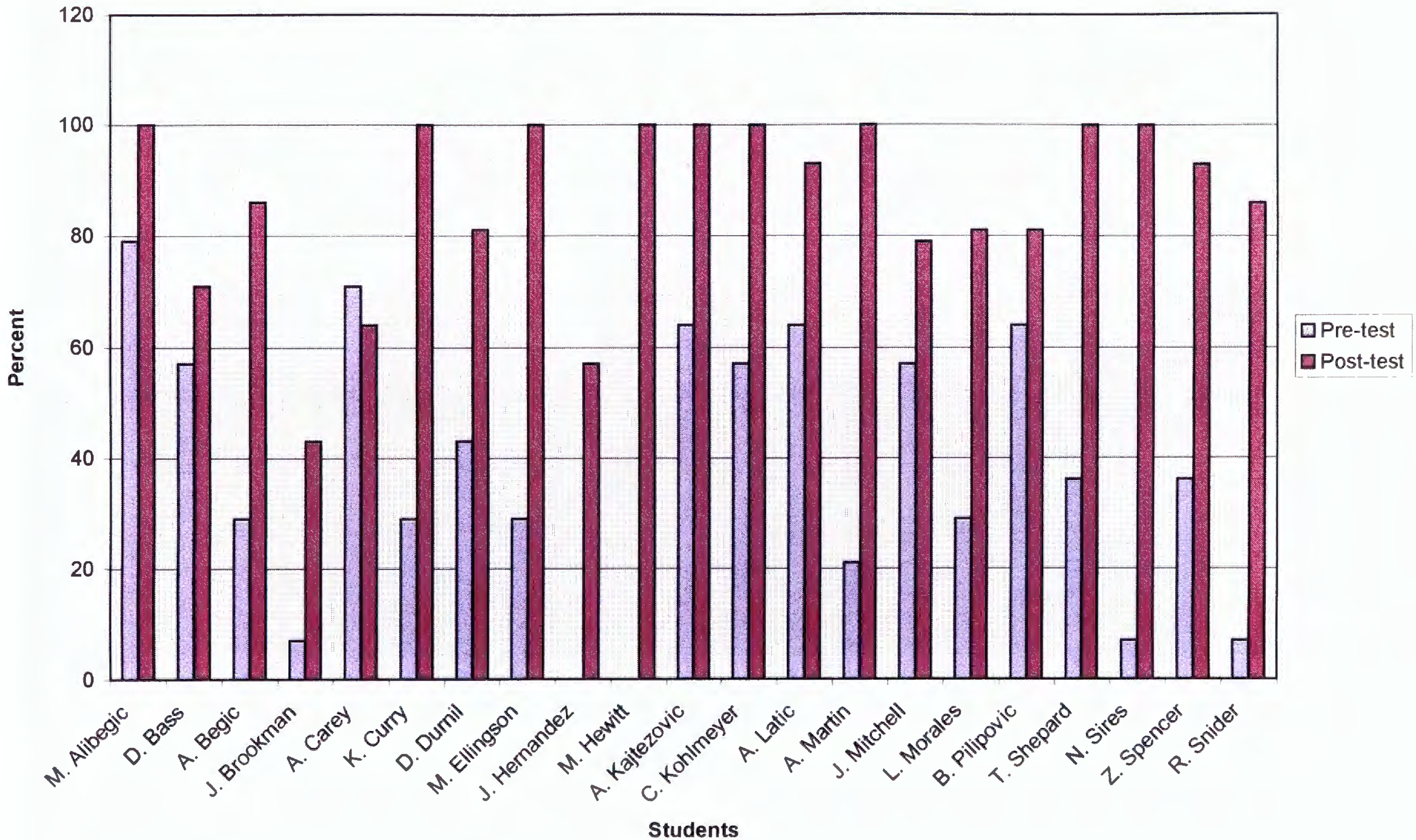
Students
Pre-tes
Post-tes

Ch. 2 Even



120
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Percent
Pre-test
Post-test
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D. Durnil
M. Ellingson
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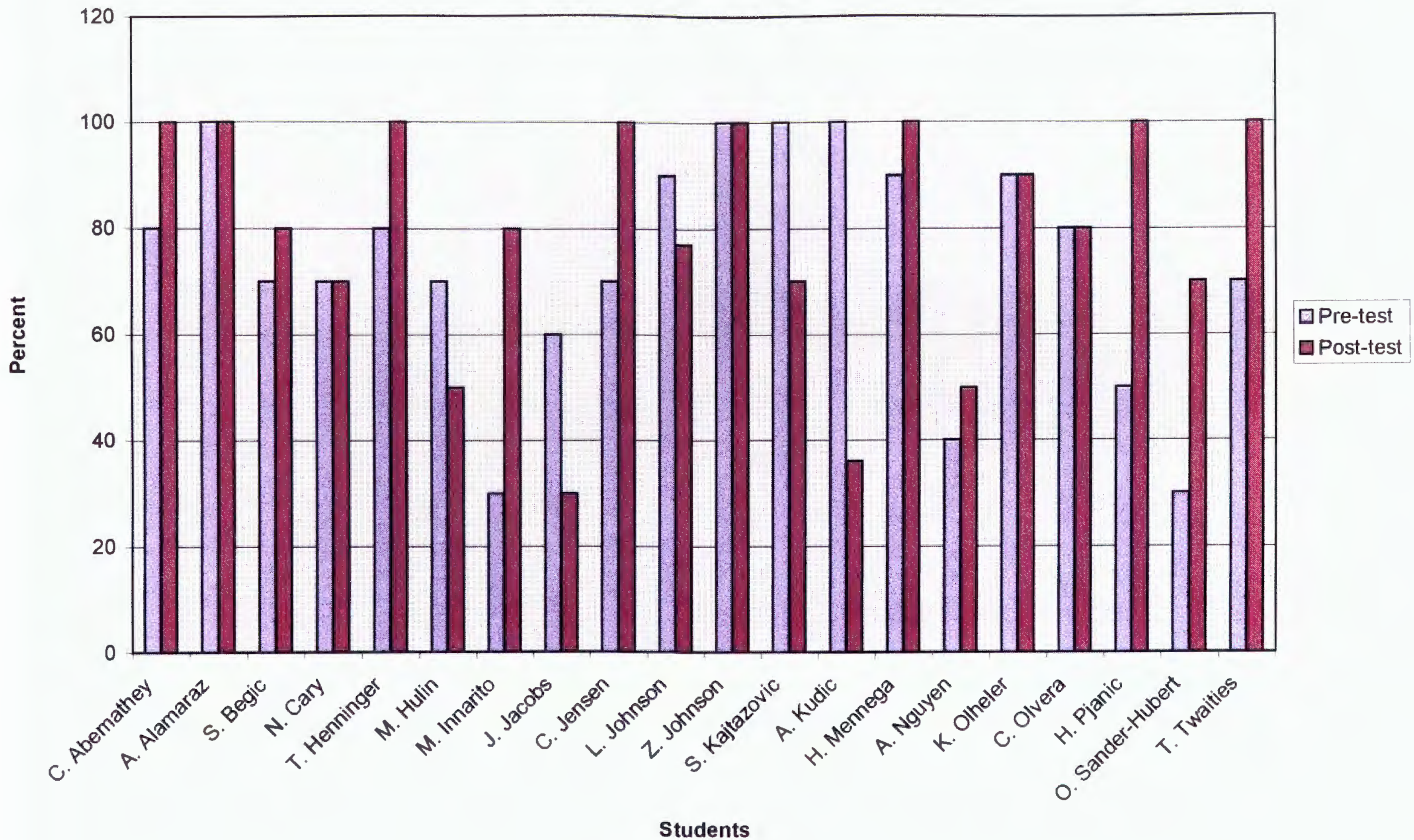
R. Snider
Students

Ch. 3 Sires



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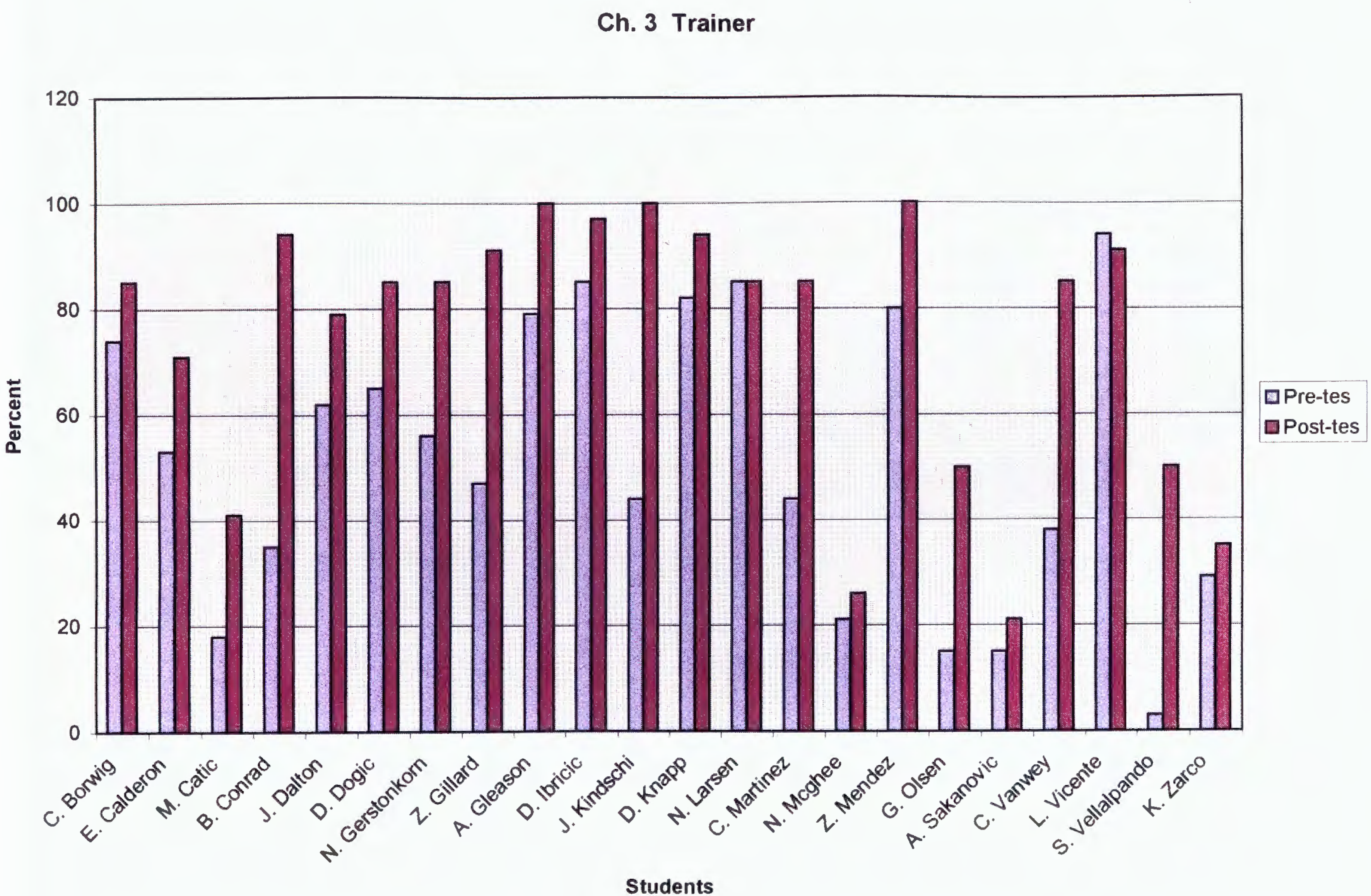
Students
Pre-test
Post-test



Ch. 3 Trainer
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Pre-tes
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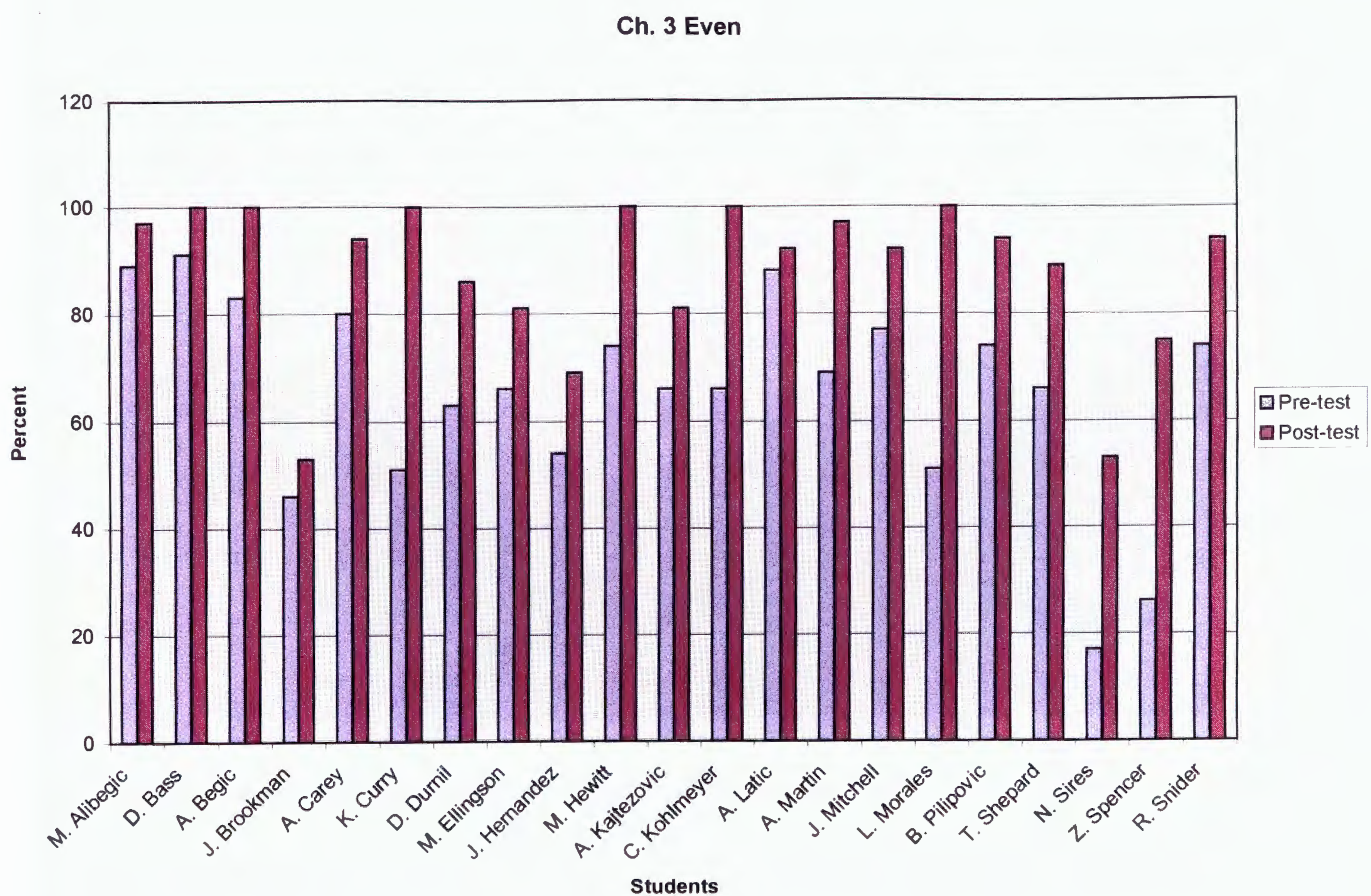
Students



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J. Hernandez
M. Hewitt
A. Kajtezovic
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A. Latic
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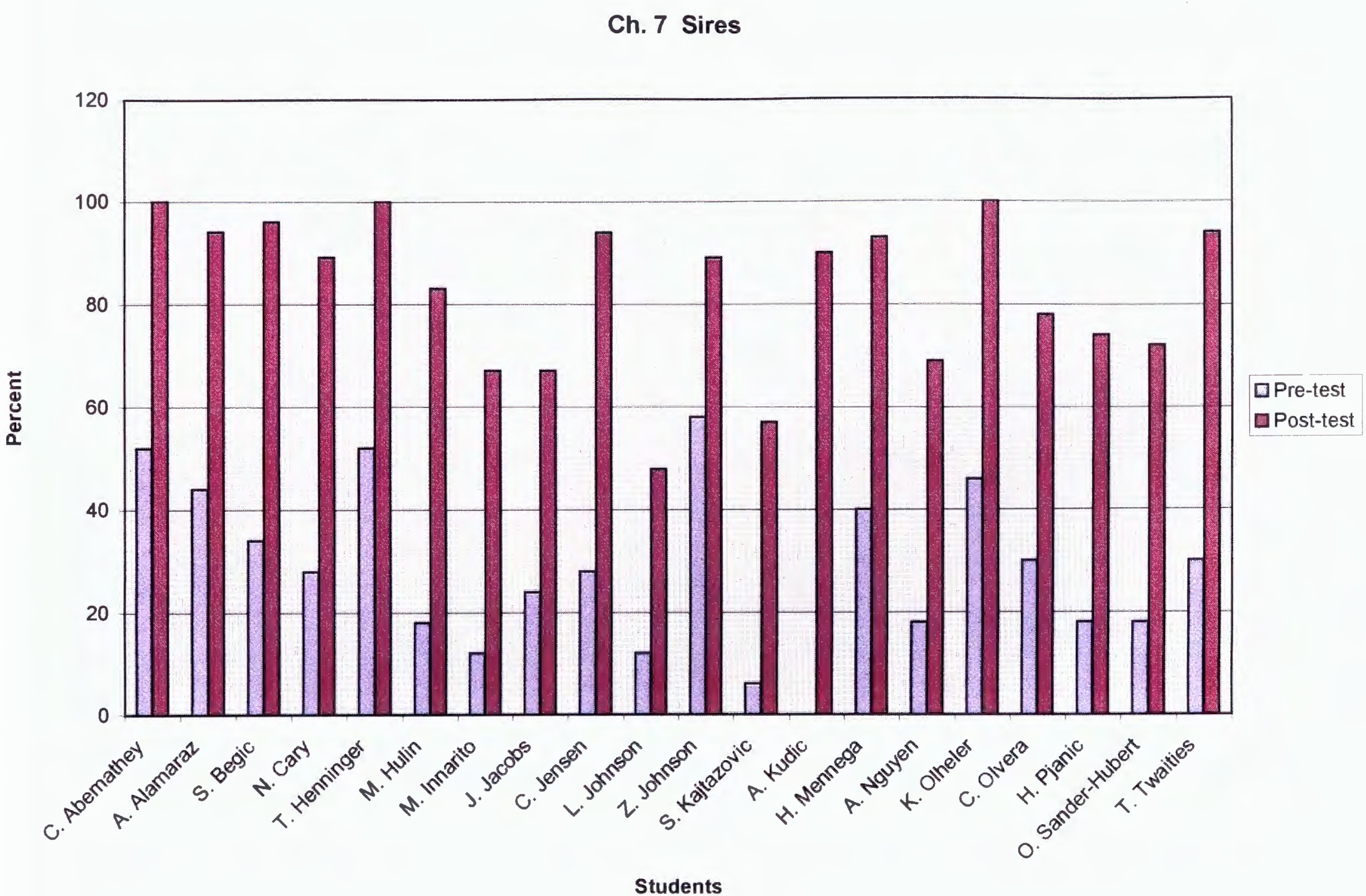
Z. Spencer
R. Snider
Students
Pre-test
Post-test



Ch. 7 Sires
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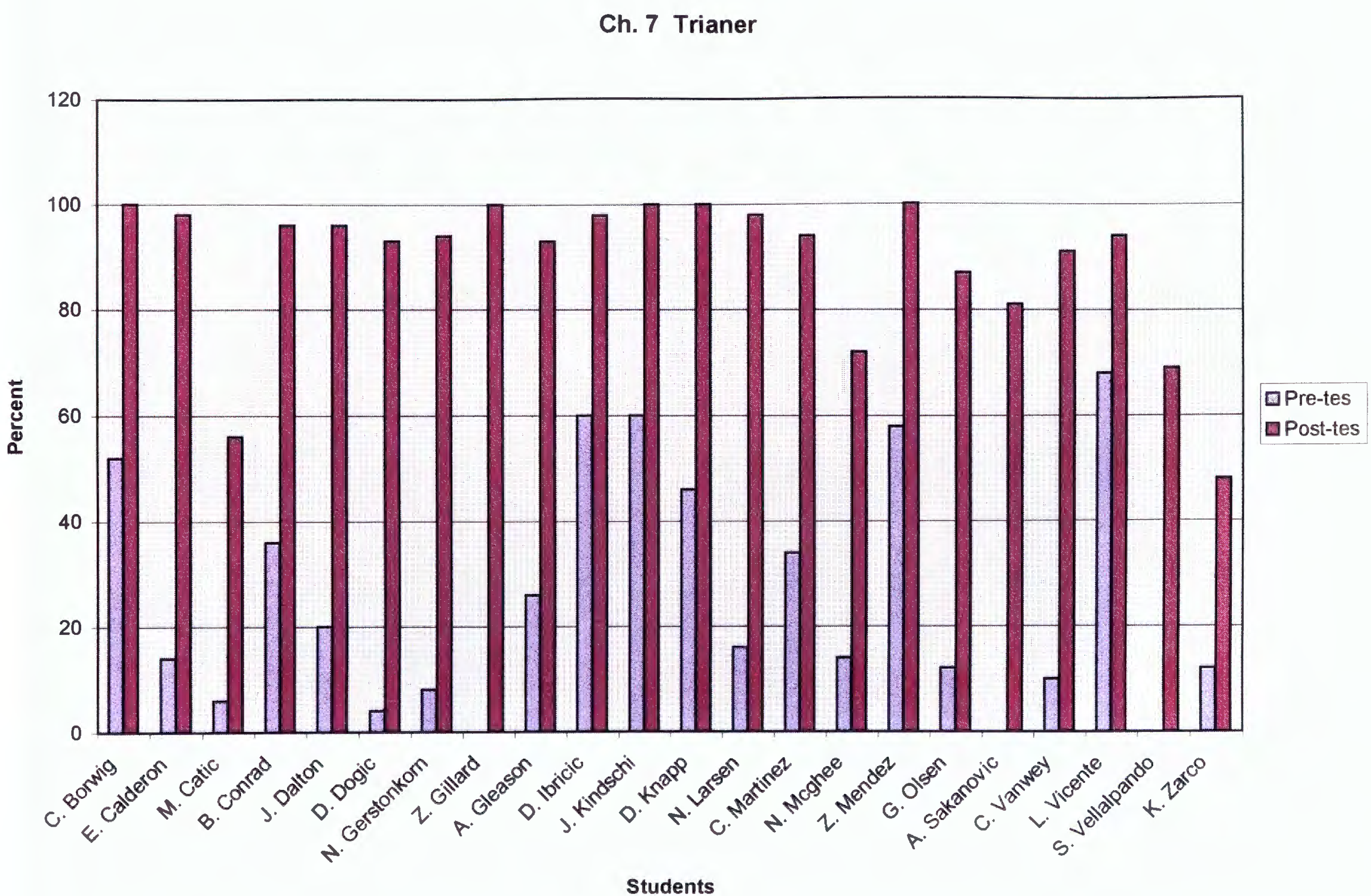
H. Pjanic
O. Sander-Hubert
T. Twaities
Students


Ch. 7 Trianer
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D. Knapp
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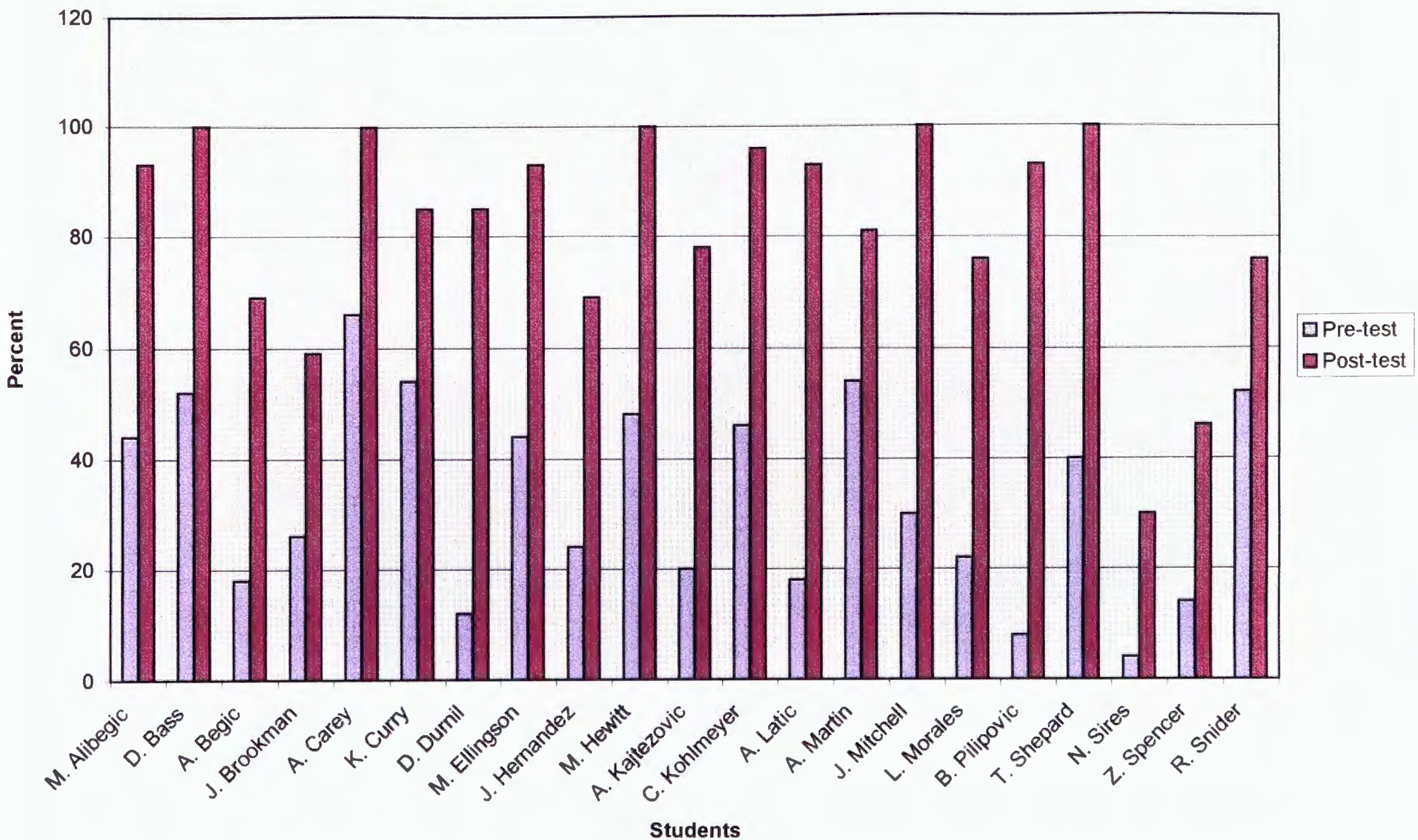
Students

Ch. 7 Even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J. Mitchell
L. Morales
B. Pilipovic
T. Shepard
N. Sires
Z. Spencer
R. Snider
Students
Pre-test
Post-test