An Evaluation of the Reasoning Mind Pilot Program at Hogg Middle School

W. A. Weber
College of Education
University of Houston

August 2003

Table of Contents

Executive Summary

The purpose of this study was to evaluate the effectiveness of the Reasoning Mind Pilot Project at Hogg Middle School in the Houston Independent School District which was implemented during the Spring 2003 semester. The study was designed to: (1) compare the mathematics achievement of seventh grade students who participated in the Reasoning Mind Pilot Project to the mathematics achievement of seventh grade students who did not participate in the Reasoning Mind Pilot Project; and (2) describe the attitudes of those students who participated in the Reasoning Mind Pilot Project regarding the Reasoning Mind instructional system they had experienced; and (3) to describe the attitudes of their teachers regarding the Reasoning Mind instructional system.

The results obtained regarding student achievement—whether measured by a pretest and a posttest designed for this purpose or the mathematics section of the state-mandated and District administered achievement test, the Texas Assessment of Knowledge and Skills—indicated that the mathematics achievement of students who participated in the Reasoning Mind Pilot Project—the experimental group—was statistically significantly higher than the mathematics achievement of students who did not participate in the Reasoning Mind Pilot Project—the control group. These results also indicated that the difference between the mathematics achievement of the experimental and control groups were also educationally meaningful; they were of practical significance. In educational research, effect size is the statistic used to determine whether the difference between the means of two groups is of practical significance. An effect size equivalent to or greater than one-third of a standard deviation unit (+0.33) is considered to be of practical significance; that is, the difference is educationally meaningful. The analyses reported in this evaluation yielded effect size differences favoring the experimental group that were: +1.66, +1.64, +0.80, +1.61, +0.79, and +.048. This is clear evidence that participation in the Reasoning Mind Pilot Project made differences that were extraordinary—difference far beyond what would be reasonable given the focus and duration of the project.

The results obtained regarding student attitudes indicated that—for the most—the students who participated in the Reasoning Mind Pilot Project were very positive about their experiences. For example, 80.00% of those students reported that they liked learning mathematics on the Reasoning Mind system, only 6.67% reported that they preferred learning mathematics in their regular classes, many reported that the Reasoning Mind system was fun, and several reported that they hoped to be able to participate in the system again next year.

The results obtained regarding teacher attitudes indicated that the two teachers of the students who participated in the Reasoning Mind Pilot Project were very positive about the Reasoning Mind system. Both teachers reported that the system kept their students engaged and motivated and that it was effective in helping their students learn mathematics.

By any standard, the results obtained in this study provide solid evidence that the Reasoning Mind Pilot Project was highly effective.

Introduction

The purpose of this study was to evaluate the effectiveness of the Reasoning Mind Pilot Project at Hogg Middle School in the Houston Independent School District which was implemented during the Spring 2003 semester. More specifically, the study was designed to: (1) compare the mathematics achievement of seventh grade students who participated in the Reasoning Mind Pilot Project to the mathematics achievement of seventh grade students who did not participate in the Reasoning Mind Pilot Project; and (2) describe the attitudes of those students who participated in the Reasoning Mind Pilot Project regarding the Reasoning Mind instructional system they had experienced; and (3) to describe the attitudes of their teachers regarding the Reasoning Mind instructional system.

This report is divided into three major sections. The first section discusses the results obtained from efforts to compare the mathematics achievement of those seventh grade students who participated in the Reasoning Mind Pilot Project to the mathematics achievement of seventh grade students who did not participate in the Reasoning Mind Pilot Project. The second section discusses the results obtained from efforts to describe the attitudes of those students who participated in the Reasoning Mind Pilot Project regarding the Reasoning Mind instructional system they had experienced. The third section discusses the results obtained from efforts to describe the attitudes of the teachers of the students who participated in the Reasoning Mind Pilot Project regarding the Reasoning Mind instructional system their students had experienced.

Student Achievement

A pretest-posttest control group research design was used to compare the mathematics achievement of those seventh grade students who participated in the Reasoning Mind Pilot Project—the experimental group—to the mathematics achievement of seventh grade students who did not participate in the Reasoning Mind Pilot Project—the control group. Randomization—and attrition—resulted in an experimental group of 30 students and a control group of 26 students. All were seventh grade students at Hogg Middle School in the Houston Independent School District, an inner-city school with a predominantly Hispanic, low-income student population. All of the students received traditional mathematics instruction as scheduled for seventh grade students; the students in the experimental group also participated in the Reasoning Mind Pilot Project.

The dependent variable, mathematics achievement, was measured using two instruments: (1) pretest (RM2003 Pretest) and posttest (RM2003 Posttest) versions of an achievement test developed specifically for this purpose and designed to assess mathematics achievement with regard to ratios, rates, and proportions; copies of the RM2003 Pretest and the RM2003 Posttest are included in Appendix A; and (2) the mathematics section of the Texas Assessment of Knowledge and Skills—the state-mandated achievement test required of all seventh grade students in Texas.

Because the RM2003 Pretest and RM2003 Posttest were developed specifically for this project, it was necessary to examine the psychometric characteristics of these tests and to determine the extent to which they are reliable and valid. Thus, for each of the tests item difficulty factors and discrimination indices were calculated, estimates of reliability using the Kuder Richardson formula 20 were made, and content validity was examined.

Item Difficulty. Item difficulty is defined as the proportion of students who responded correctly to that item. The higher this proportion is, the easier the item is. The difficulty factor or difficulty level for a particular item can range from a minimum of .00 to a maximum of 1.00. A difficulty factor of .00 indicates that everyone either omitted the item or answered it incorrectly while a difficulty factor of 1.00 indicates that everyone answered the item correctly. Thus, the higher the difficulty factor, the easier the item. An item with a difficulty factor between .00 and .49 is considered to be a "hard" item, an item with a difficulty factor between .50 and .84 is considered to be a "medium" item, and an item with a difficulty factor between .85 and 1.00 is considered to be an "easy" item (Sax, 1997).

Item Discrimination. Item discrimination is the extent to which an item differentiates between those students with the highest and lowest scores on the total test. If the highest-scoring and the lowest-scoring students—based on their total test—perform equally well on an item, that item does not discriminate between the two groups and, therefore, is "useless for measuring individual differences" (Sax, 1997, page 240). Thus, it is desirable for a large proportion of the highest-scoring students to respond correctly to each item and for a smaller proportion of the lowest-scoring students to respond correctly to each item.

The extent to which an item discriminates can be indicated by a discrimination index. The discrimination index is the difference between the proportion of students who responded correctly in highest-scoring group and the lowest-scoring group. In this case, students whose total scores were in the upper quartile were considered to be the highest-scoring group and students whose total scores were in the lower quartile were considered to be the lowest-scoring group. The discrimination index for each item was calculated by finding the difference between the proportion of those in the upper quartile who responded correctly and the proportion of those in the lower quartile who responded correctly. The discrimination index can range from +1.00 to –1.00. If everyone in the upper quartile responded correctly and everyone in the lower quartile responded incorrectly, the discrimination index would be +1.00 as the difference is 100%, which—given as a proportion—is +1.00. An item that has a low discrimination index contributes little to the measurement of individual differences; an item that has a negative discrimination index may be a poor item and may need to be revised.

Table 1 on the next page provides the difficulty factor and discrimination index obtained for each of the items on the RM2003 Pretest and the RM2003 Posttest.

Table 1

Psychometric Characteristics of the Reasoning Mind Pretest and Posttest: Difficulty Factors and Discrimination Indices

	Difficulty Factors		Discrimination Indices	
Item	Pretest	Posttest	Pretest	Posttest
1	.96	.91	.00	.21
2	.29	.45	.71	.79
3	.36	.55	.64	.64
4	.29	.52	.57	.79
5	.57	.70	.50	.64
6	.04	.05	.07	.07
7	.21	.27	.00	-.07
8	.02	.04	.00	.07
9	.75	.70	.43	.50
10	.45	.73	.50	.43
11	.66	.63	.21	.79
12	.46	.68	.29	.43
13	.79	.75	.50	.21
14	.45	.52	.79	.93
15	.11	.16	.36	.43
16	.21	.38	.21	.57
17	.07	.16	.29	.57
18	.05	.02	.07	.00
19	.18	.36	.29	.57
20	.09	.11	.29	.21
21	.18	.41	.29	.71
22	.39	.70	.50	.50
23	.14	.25	.36	.57
24	.00	.09	.00	.29
25	.02	.18	.07	.36
26	.04	.27	-.07	.36
27	.04	.09	.14	.29
28	.02	.04	.07	.14
29	.00	.16	.00	.43
30	.00	.07	.00	.21
31	.07	.23	.14	.36
32	.00	.09	.00	.29

As shown in Table 1, the difficulty factors for the RM2003 Pretest ranged from .00 to .96 and the difficulty factors for the RM2003 Posttest ranged from .02 to .91 indicating that both tests had items that were of greatly varying difficulty. Of the thirty-two items on the RM2003 Pretest, the difficulty factor for only one item—the first item—was .86 or greater indicating that it was the only “easy” item for the students, the difficulty factors for ten items were between .50 and .85 indicating that they were “medium” items for the students, and the difficulty factors for the remaining twenty-one items were .49 or less indicting that they were “hard” items for the students. Of the thirty-two items on the RM2003 Posttest, only one item—again, the first item—had a difficulty factor that was .86 or greater indicating that it was the only “easy” item for the students, the difficulty factors for nine items were between .50 and .85 indicating that they were “medium” items for the students, and the difficulty factors for the remaining twenty-three items were .49 or less indicting that they were “hard” items for the students. The average difficulty factors for these tests—.25 for the RM2003 Pretest and .35 for the RM2003 Posttest—were lower than the .40 to .75 standard recommended by Marshall and Hales (1971) indicating that both tests were—on average—very difficult for these students.

As also shown in Table 1, the item discrimination indices for the RM2003 Pretest ranged from -.07 to +.79 and averaged +.26 and the item discrimination indices for the RM2003 Posttest ranged from -.07 to +.93 and averaged +.42. Two items—item 26 on the pretest and item 7 on the posttest—were negative, but only slightly so; seven of the items on the RM2003 Pretest and three of the items on the RM2003 Posttest—as indicated by discrimination indices of .00—did not discriminate. That is because none of the higher-scoring or lower-scoring students got the correct answer for any of these items and, therefore, the items did not discriminate. As is desirable, on twenty-four RM2003 Pretest items and on twenty-eight RM2003 Posttest items, a larger proportion of higher-scoring students responded correctly to each item and a smaller proportion of lower-scoring students responded correctly to each item. In short, both tests discriminated as would be expected of a test that was found to be difficult for students.

Test Reliability. Reliability is the extent to which a test measures consistently what it is that it measures; a test cannot be valid if it is not reliable—if it does not measure consistently. A number of techniques can be used to estimate the reliability of achievement tests such as the RM2003 Pretest and the RM2003 Posttest. In this case, the most appropriate technique is the Kuder Richardson formula 20—a technique for estimating the internal consistency of a test—the inter-item consistency. The Kuder Richardson formula 20 is appropriate when the goal is to estimate the reliability of a test from a single administration and it has been determined that the items on that test vary in difficulty. The Kuder Richardson formula 20 estimates internal consistency by determining the extent to which measurements on a single form are intercorrelated; it yields a correlation coefficient that ranges from .00 to 1.00. A higher correlation coefficient indicates that a test is reliable while a lower correlation coefficient indicates that a test is unreliable. Diederich (1973) suggests that achievement tests such the RM2003 Pretest and the RM2003 Posttest should have reliabilities above +.60. Table 2 on the next page presents the coefficients obtained for those two tests.

Table 2

Psychometric Characteristics of the Reasoning Mind Pretest and Posttest: Kuder Richardson Formula 20 Coefficients

Test	KR_{20}
Pretest	+.68
Posttest	+.85

As shown in Table 2, use of the Kuder Richardson formula 20 yielded correlation coefficients of +.68 for the RM2003 Pretest and +.85 for the RM2003 Posttest. Each of these correlation coefficients would be considered to be quite high as both exceed the criterion of +.60 recommended by Diederich (1973). Clearly, the results obtained from use of the Kuder Richardson formula 20 provide very convincing evidence of high inter-item reliability for each of these tests. This suggests that each of them is highly reliable; that is, each measures consistently what it is that it measures.

Test Validity. Validity is the extent to which an instrument measures what it purports to measure. In the case of achievement tests such as the RM2003 Pretest and the RM2003 Posttest, two types of validity are considered: (1) predictive validity; and (2) content validity.

Predictive validity is the extent to which a student's performance on a test of unknown validity is predictive—related to—his or her performance on a test of known validity that purports to measure the same content. Unfortunately, in this case, tests of known validity were not administered as posttests making estimates of predictive validity impossible. However, as noted above, the process followed in the development of these tests gives every reason to believe that each of them is valid. That is, each measures the content that is to be taught at the grade level for which it was developed.

Content validity is the extent to which an achievement test measures the content that was to have been taught—the written curriculum. Clearly, the processes used to develop the RM2003 Pretest and the RM2003 Posttest were intended to ensure that the tests had content validity. That is, the writing team took great care to make certain that each of the test items was reflective of the instructional objectives prescribed for seventh grade students in the areas of ratios, rates, and proportions. However, in an effort to further establish the content validity of the tests, they were subjected to an external review. Copies of the RM2003 Pretest and the RM2003 Posttest were submitted to three professional educators with expertise regarding the secondary school mathematics curriculum in Texas; those experts were: Dr. Michael Connell, Associate Professor of Mathematics Education in the Department of Curriculum and Instruction in the College of Education at the University of Houston; Dr. Jan Moore, Coordinator of Secondary School Mathematics in the Fort Bend Independent School District in Sugar Land, Texas; and Dr. Susan Williams, Associate Professor of Mathematics Education in the Department of Curriculum and Instruction in the College of Education at the University of Houston. They were asked to: (1) assess the extent to which the content measured in the RM2003 Pretest and the RM2003 Posttest was reflective of the content that is to be taught in the seventh grade in Texas schools; (2) assess the extent to which the two tests were equivalent forms; and (3) assess the rigor of the items. All three of the experts agreed that the content assessed in the test focused on the knowledge and skills specified in the state-mandated curriculum—the Texas Essential Knowledge and Skills—for seventh grade mathematics with regard to ratios, rates, and proportions. All three also agreed that the two tests were equivalent forms and pointed out that the items were parallel in construction; that is, item 1 on the RM 2003 Pretest was identical in format to item 1 on the RM2003 Posttest. Finally, all three experts also agreed that the tests were rigorous. Copies of their reviews are included in Appendix B.

Results Obtained with Regard to Mathematics Achievement as Measured by the RM2003 Posttest. The student mathematics achievement pretest and posttest data that were collected using the RM2003 Pretest and RM2003 Posttest were analyzed using analysis of covariance procedures in which mathematics achievement as measured by the RM2003 Posttest was the dependent variable and mathematics achievement as measured by the RM2003 Pretest served as the covariate—the analysis most appropriate when using a pretest-posttest control group research design. In addition, analysis of covariance procedures were also used to compare the achievement of the experimental group and control group on those RM2003 Posttest items thought to be "easiest," "more difficult," and "most difficult" by those who developed the RM2003 Pretest and the RM2003 Posttest.

Table 3 on the next page, presents a listing of the items according to their difficulty classification ("1" for "easiest," "2" for "more difficult," and "3" for "most difficult") by the developers of the RM2003 Pretest and the RM2003 Posttest. Table 3 also presents the mean difficulty factor for items in those three difficulty classifications. If the difficulty classifications are valid, the "easiest" items should have the highest mean difficulty factor and the "most difficult" items should have the lowest mean difficulty factor. Table 4 presents the correlation coefficients that were obtained when the difficulty classifications given the items were correlated with each of the difficulty factors obtained for those items using the Spearman rank-order correlation technique.

These correlations were performed in an effort to validate the difficulty classifications. That is, a high correlation—a correlation coefficient of +.70 or better—would suggest that the items were properly classified—and that sub-analyses of those items would be justified—while a low correlation would suggest that the items were not properly classified—and that sub-analyses of those items would not be warranted.

Table 3

Difficulty Classifications and Difficulty Factors for the Reasoning Mind Pretest and Posttest Items

		Difficulty Factors	
Difficulty Classifications	Items[1]	Pretest Mean	Posttest Mean
Easiest	1, 2, 3, 4, 5, 9, 10, 11, 12, 13, 14, and 16	.52	.63
More Difficult	6, 7, 15, 17, 18, 19, 20, 21, and 22	.15	.25
Most Difficult	8, 23, 24, 25, 26, 27, 28, 29, 30, 30, 31, and 32	.03	.14

[1]Difficulty classifications were the same for RM2003 Pretest and RM2003 Posttest items.

Table 4

Results Obtained from Spearman Rank-Order Correlation Technique: Relationship Between Difficulty Classifications and Difficulty Factors for Pretest and Posttest

Test	r_s	*p*
Pretest	+.89	<.01
Posttest	+.77	<.01

The results presented in Table 3 provide convincing evidence that the difficulty classifications made by the developers of the tests were valid and that subsequent sub-analyses were justified. The mean difficulty factors for the “easiest” items were .52 for the RM2003 Pretest and .63 for the RM2003 Posttest, the mean difficulty factors for the “more difficult” items were .15 for the RM2003 Pretest and .25 for the RM2003 Posttest, and the mean difficulty factors for the “most difficult” items were .03 for the RM2003 Pretest and .14 for the RM2003 Posttest. This indicates that the items thought by the test developers to be the “easiest” items did prove to be the easiest items, the “more difficult” items did prove to be more difficult than the “easiest” items, and the “most difficult” items did prove to be most difficult—more difficult than the “more difficult” items.

Further confirmation of this conclusion is found in the results obtained from the analyses using the Spearman rank-order correlation technique presented in Table 4. The correlation coefficient of +.89 for the RM2003 Pretest and the correlation coefficient of +.77 for the RM2003 Posttest indicate strong relationships between the difficulty classifications given and the difficulty factors obtained. Thus, sub-analyses in which mathematics achievement was measured by the “easiest,” “more difficult,” and “most difficult” items were justified.

As noted earlier, a pretest-posttest control group research design was used to compare the mathematics achievement of those seventh grade students who participated in the Reasoning Mind Pilot Project—the experimental group—to the mathematics achievement of seventh grade students who did not participate in the Reasoning Mind Pilot Project—the control group. Randomization—and attrition—resulted in an experimental group of 30 students and a control group of 26 students. When using a pretest-posttest control group research design—a very powerful research design—the “preferred statistical method is analysis of covariance in which the posttest mean of the experimental group is compared with the posttest mean of the control group with the pretest scores used as a covariate” (Gall, Gall, and Borg, 2003, page 393). In effect, the use of the pretest scores as a covariate “equates” the experimental and control groups, creates adjusted mean scores, and allows differences between adjusted posttest means to be attributed to the experimental treatment and not to initial differences. Analysis of covariance is “a procedure for determining whether the difference between the mean scores of two or more groups on one or more dependent variables is statistically significant” (Gall, Gall, and Borg, 2003, page 618).

In each analysis, the ninety-five percent confidence level (p <.05) was used as the criterion for statistical significance and an effect size equivalent to one-third of a standard deviation ($\Delta = +0.33$) was used as the criterion for educational meaningfulness. Analysis of variance procedures—as with other inferential statistical procedures—yields a probability value (p) that provides an estimation of the odds that the results obtained from the analysis might have occurred by chance. That is, a difference between two means is said to be statistically significant if that difference is unlikely to have occurred by chance. In an analysis of variance, a p of .05 indicates that the difference between the posttest mean of the experimental group and the posttest mean of the control group exceeds that mean difference that would be found five times in a hundred samples if the population mean difference was zero. In short, it is very unlikely that such a difference would have occurred by chance. When the ninety-five percent confidence level is used and a p value that is equal to or less than .05 is obtained, the difference is said to be statistically significant. The probability of obtaining such an outcome is only five times (or less) in one hundred.

Effect size is a technique for assessing the magnitude of a difference between the means of two groups. Effect size takes into account the size of the difference between means that is obtained, regardless of whether that difference is statistically significant. "The effect size statistic is helpful in judging the practical significance of a research result" (Gall, Gall, and Borg, 2003, page 148). Generally, an effect size of 0.33 is viewed as indicating that a difference between two means is educationally meaningful. An effect size of 0.33 indicates that the mean of one of the groups was one-third of a standard deviation unit greater than that of the other group—and that this difference is educationally meaningful and of practical significance.

The results obtained from the four analyses of covariance are presented in Tables 5 through 8 and Figures 1 through 4 on the following pages.

As shown in Table 5, the first analysis of covariance—the analysis that examined total scores—yielded an F ratio of 42.58 which was statistically significant (p <.001) and an effect size ($\Delta = +1.66$) which was educationally meaningful. The adjusted mean score for the experimental group was 13.86 and the adjusted mean score for the control group was 8.20; the difference between those adjusted means was statistically significant. Therefore, it is clearly warranted to suggest that the mathematics achievement of the seventh grade students who participated in the Reasoning Mind Pilot Project—as measured by the RM2003 Posttest—is statistically significantly higher than the mathematics achievement of the seventh grade students who did not participate in the Reasoning Mind Pilot Project. Further, the effect size ($\Delta = +1.66$) suggests that this difference is of practical significance.

These results are remarkable when one considers the length of the experimental treatment in which the experimental group participated. Between the administrations of the pretest and the posttest, the students in the Pilot Program had the opportunity to participate in only twenty-nine, one and one-half hour sessions beginning on January 28 and ending on May 20. Thus, each of the students in the experimental group received a maximum of forty-three and a half hours of instruction.

Table 5

Results Obtained from Analysis of Covariance of Pretest and Posttest Achievement (Total Scores) of Hogg Middle School Students

Analysis of Covariance

Source	Sum of Squares	*df*	Mean Squares	*F*	*p*
Group	424.80	1	424.80	42.58	<.001
Pretest	409.04	1	409.04	41.00	<.001
Error	528.79	53	9.98		

Means

		Pretest		Posttest			
Group	*N*	Mean	*SD*	Mean	*SD*	Adjusted Mean	Δ
Experimental	30	8.57	3.31	14.43	4.73	13.86	+1.66
Control	26	7.16	3.17	7.54	3.41	8.20	
Total	56	7.89	3.30	11.23	5.39		

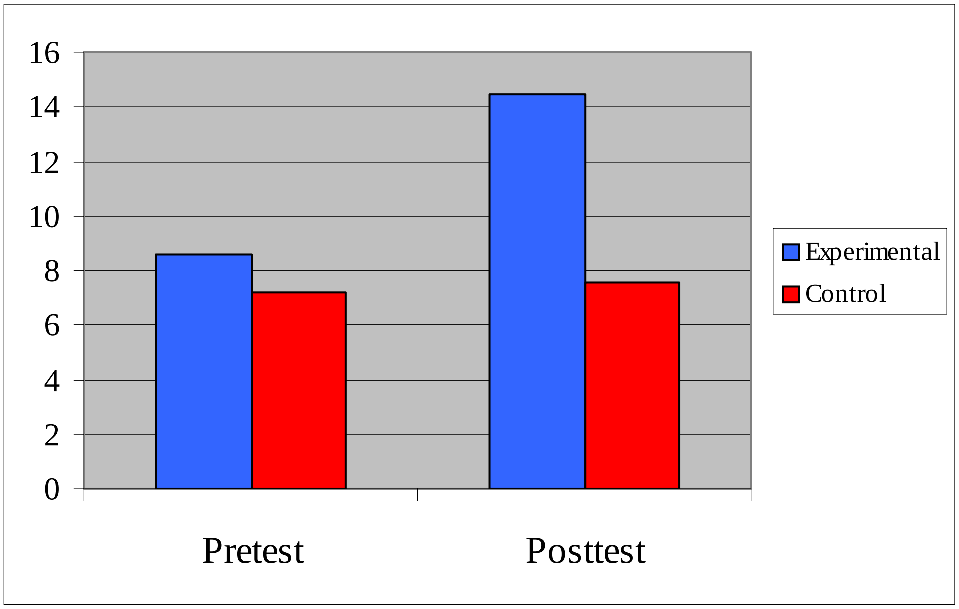


Figure 1

Results Obtained from Analysis of Covariance of Pretest and Posttest Achievement (Total Scores) of Hogg Middle School Students

As shown in Table 6, the second analysis of covariance—the analysis that examined the “easiest” scores—yielded an *F* ratio of 50.74 that was statistically significant (p <.001) and an effect size (Δ = +1.64) that was educationally meaningful. The adjusted mean score for the experimental group was 9.29 and the adjusted mean score for the control group was 5.43; the difference between those adjusted means was statistically significant. Therefore, it is clearly reasonable to suggest that the mathematics achievement of the seventh grade students who participated in the Reasoning Mind Pilot Project—as measured by the “easiest” items on the RM2003 Posttest—is statistically significantly higher than the mathematics achievement of the seventh grade students who did not participate in the Reasoning Mind Pilot Project. Further, the effect size (Δ = +1.64) suggests that this difference is also educationally meaningful—that this difference is of practical significance.

Table 6

Results Obtained from Analysis of Covariance of Pretest and Posttest Achievement (Scores for Easiest Items) of Hogg Middle School Students

Analysis of Covariance

Source	Sum of Squares	*df*	Mean Squares	*F*	*p*
Group	205.71	1	205.71	50.74	<.001
Pretest	63.87	1	63.87	15.75	<.001
Error	214.87	53	4.05		

Means

		Pretest		Posttest			
Group	*N*	Mean	*SD*	Mean	*SD*	Adjusted Mean	Δ
Experimental	30	6.47	2.40	9.40	2.19	9.29	+1.64
Control	26	5.96	2.43	5.31	2.36	5.43	
Total	56	6.23	2.40	7.50	3.05		

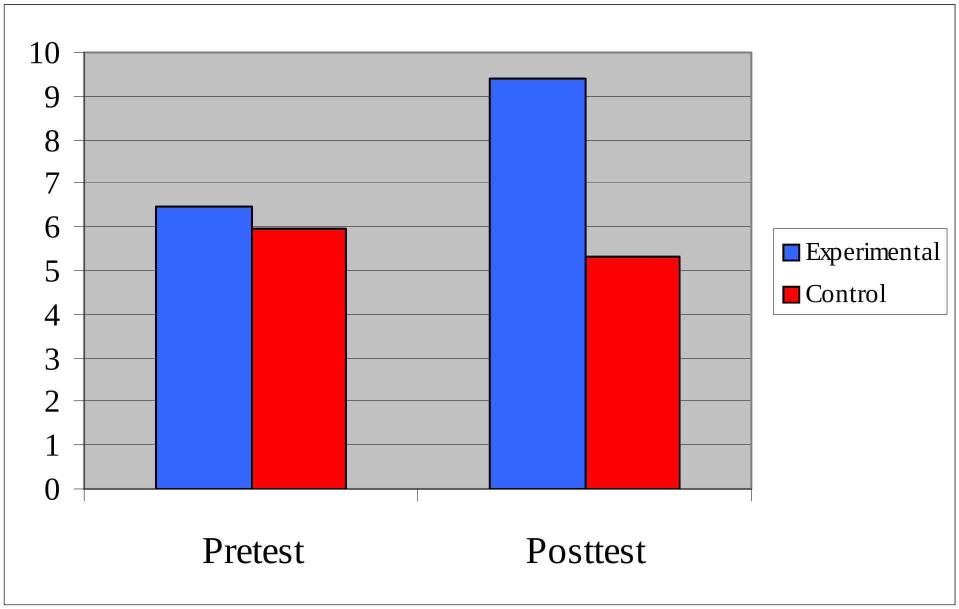


Figure 2

Results Obtained from Analysis of Covariance of Pretest and Posttest Achievement (Scores for Easiest Items) of Hogg Middle School Students

As shown in Table 7, the third analysis of covariance—the analysis that examined the "more difficult" scores—yielded an F ratio of 4.94 that was statistically significant (p = .030) and an effect size (Δ = +0.80) that was educationally meaningful. The adjusted mean score for the experimental group was 2.58 and the adjusted mean score for the control group was 1.83; the difference between those adjusted means was statistically significant. Therefore, it is quite reasonable to suggest that the mathematics achievement of the seventh grade students who participated in the Reasoning Mind Pilot Project—as measured by the "more difficult" items on the RM2003 Posttest—is statistically significantly higher than the mathematics achievement of the seventh grade students who did not participate in the Reasoning Mind Pilot Project. Further, the effect size (Δ = +0.80) suggests that this difference is also educationally meaningful—that this difference is of practical significance.

Table 7

Results Obtained from Analysis of Covariance of Pretest and Posttest Achievement (Scores for More Difficult Items) of Hogg Middle School Students

Analysis of Covariance

Source	Sum of Squares	*df*	Mean Squares	*F*	*p*
Group	6.81	1	6.81	4.94	.030
Pretest	30.94	1	30.94	22.46	<.001
Error	73.03	53	1.38		

Means

		Pretest		Posttest			
Group	*N*	Mean	*SD*	Mean	*SD*	Adjusted Mean	Δ
Experimental	30	1.73	1.20	2.87	1.68	2.58	+0.80
Control	26	0.85	0.97	1.50	0.95	1.83	
Total	56	1.32	1.18	2.23	1.54		

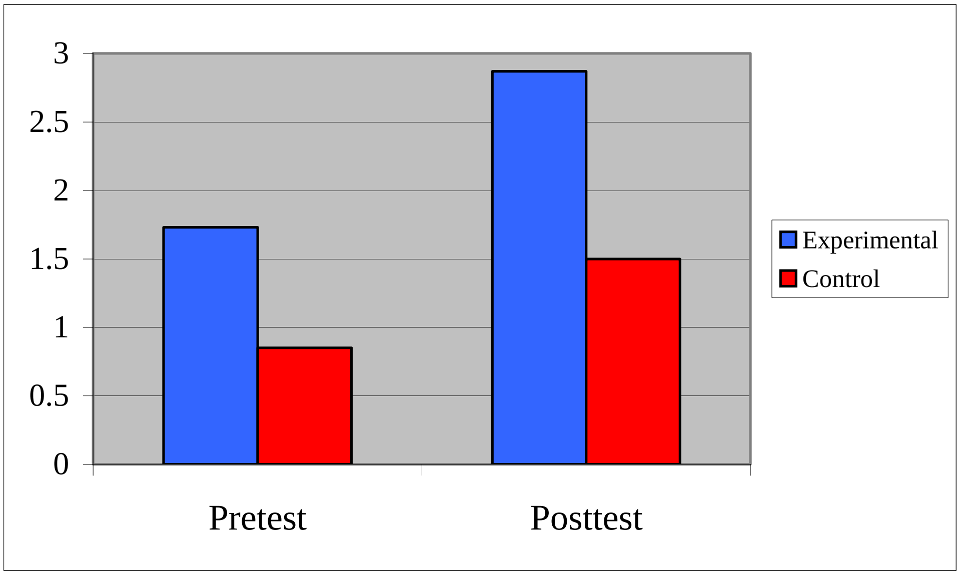


Figure 3

Results Obtained from Analysis of Covariance of Pretest and Posttest Achievement (Scores for More Difficult Items) of Hogg Middle School Students

As shown in Table 8, the fourth analysis of covariance—the analysis that examined the "most difficult" scores—yielded an F ratio of 10.25 which was statistically significant (p = .002) and an effect size (Δ = +1.61) which was educationally meaningful. The adjusted mean score for the experimental group was 2.15 and the adjusted mean score for the control group was 0.75; the difference between those adjusted means was statistically significant. Therefore, it is perfectly reasonable to suggest that the mathematics achievement of the seventh grade students who participated in the Reasoning Mind Pilot Project—as measured by the "most difficult" items on the RM2003 Posttest—is statistically significantly higher than the mathematics achievement of the seventh grade students who did not participate in the Reasoning Mind Pilot Project. Further, the effect size (Δ = +1.61) suggests that this difference is also educationally meaningful—that this difference is of practical significance.

Table 8

Results Obtained from Analysis of Covariance of Pretest and Posttest Achievement (Scores for Most Difficult Items) of Hogg Middle School Students

Analysis of Covariance

Source	Sum of Squares	*df*	Mean Squares	*F*	*p*
Group	27.48	1	27.48	10.25	.002
Pretest	5.19	1	5.19	1.94	.170
Error	142.09	53	2.68		

Means

		Pretest		Posttest			
Group	*N*	Mean	*SD*	Mean	*SD*	Adjusted Mean	Δ
Experimental	30	0.37	0.56	2.17	2.10	2.15	+1.61
Control	26	0.31	0.68	0.73	0.87	0.75	
Total	56	0.34	0.61	1.50	1.79		

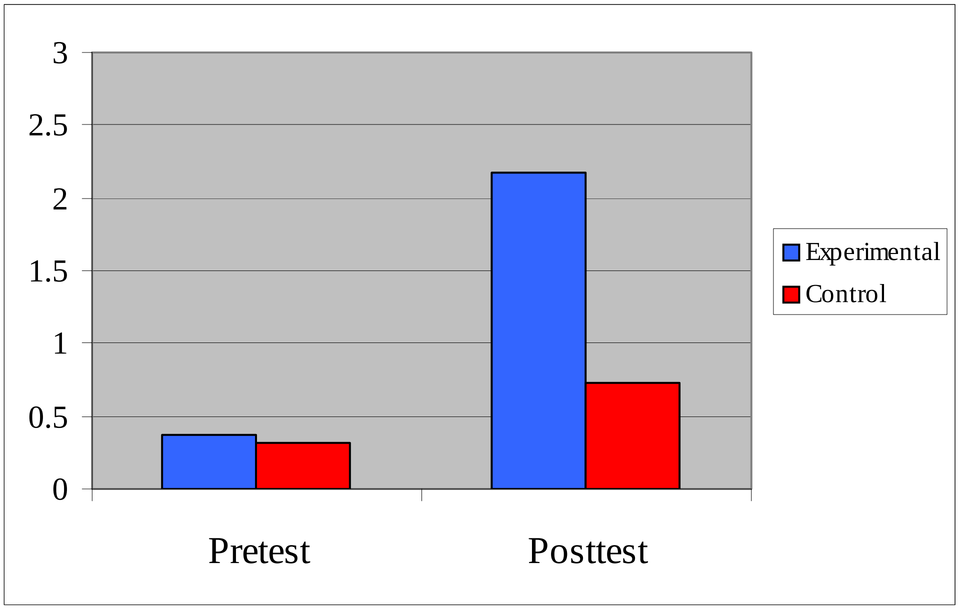


Figure 4

Results Obtained from Analysis of Covariance of Pretest and Posttest Achievement (Scores for Most Difficult Items) of Hogg Middle School Students

Clearly, the results obtained when a pretest-posttest control group research design, performance on the RM2003 Pretest and RM2003 Posttest, and analyses of covariance were used to compare the mathematics achievement of the seventh grade students who participated in the Reasoning Mind Pilot Program to the mathematics achievement of the seventh grade students who did not participate in the Program indicate that the Program was effective. As noted earlier, these results are all the more remarkable when one considers the length of the experimental treatment to which students in the experimental group were exposed.

Results Obtained with Regard to Mathematics Achievement as Measured by the Texas Assessment of Knowledge and Skills and by the Stanford Achievement Test. In an attempt to confirm these results, two additional analyses were performed. The first analysis used a posttest only control group research design, performance on the mathematics section of the Texas Assessment of Knowledge and Skills administered at the end of seventh grade as the dependent variable, performance on the mathematics section of the Texas Assessment of Academic Skills administered at the end of sixth grade as the covariate, and analysis of covariance procedures. The assumption here was that participation in the Reasoning Mind Pilot Project—a program that emphasized mathematical knowledge and skills related to ratios, rates, and proportions—might have a positive effect on the performance of students on the state-mandated achievement test in mathematics—the mathematics section of the Texas Assessment of Knowledge and Skills. Although a very optimistic assumption given the amount of instruction the students in the experimental group experienced, nonetheless, it was an assumption that could be empirically tested using test data from tests that were administered by the school as a part of the school district's testing protocol. The mathematics section of the Texas Assessment of Academic Skills had been administered to the students in both the experimental and control groups toward the end of the 2001-2002 school year when those students were in the sixth grade and long before the Reasoning Mind Pilot Project was implemented. The mathematics section of the Texas Assessment of Knowledge and Skills was administered to the students in both the experimental and control groups on April 30—after the students in the experimental group would have been exposed to a maximum of only twenty-two, one and one-half hour sessions—a total of only thirty-three hours of instruction—between the pretest and the posttest.

The second analysis used a posttest only control group research design, performance on the mathematics section of the Texas Assessment of Knowledge and Skills administered on April 30 as the dependent variable, performance on the mathematics section of the Stanford Achievement Test, Ninth Edition, administered during the first week of March as the covariate, and analysis of covariance procedures. As earlier, the assumption here was that participation in the Reasoning Mind Pilot Project—a program that emphasized mathematical knowledge and skills related to ratios, rates, and proportions—might have a positive effect on the performance of students on the state-mandated achievement test in mathematics—the mathematics section of the Texas Assessment of Knowledge and Skills. It was an assumption that could also be empirically tested using a different set of test data from tests that were administered by the school as a part of its testing protocol. As noted above, the mathematics section of the Stanford Achievement Test, Ninth Edition, had been administered during the first week of March and the mathematics section of the Texas Assessment of Knowledge and Skills was administered on April 30. Therefore, the experimental group would have had an opportunity to participate in only fourteen, one and one-half hour sessions between the administration of the pretest and the posttest—a total of only twenty-one hours of instruction.

The results obtained from these two analyses are presented in Tables 9 and 10 and Figures 5 and 6 on the following pages. As earlier, in both instances, the ninety-five percent confidence level ($p < .05$) was used as the criterion for statistical significance and an effect size equivalent to one-third of a standard deviation ($\Delta = +0.33$) was used as the criterion for educational meaningfulness.

Table 9

Results Obtained from Analysis of Covariance of Pretest Achievement (Sixth Grade Texas Assessment of Academic Skills Scores) and Posttest Achievement (Seventh Grade Texas Assessment of Knowledge and Skills) of Hogg Middle School Students

Analysis of Covariance

Source	Sum of Squares	*df*	Mean Squares	*F*	*p*
Group	346.99	1	346.99	9.50	.003
Pretest	914.55	1	914.55	25.05	<.001
Error	1862.37	51	36.52		

Means

		Pretest		Posttest			
Group	*N*	Mean	*SD*	Mean	*SD*	Adjusted Mean	Δ
Experimental	29	87.38	4.35	29.90	7.96	30.21	+0.79
Control	25	87.96	2.30	25.48	6.46	25.11	
Total	54	87.65	3.54	27.85	7.57		

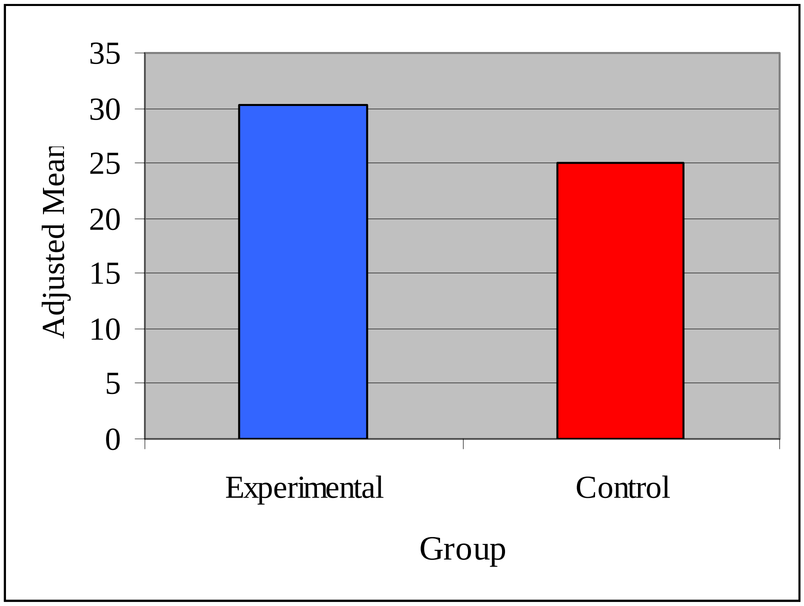


Figure 5

Results Obtained from Analysis of Covariance of Pretest Achievement (Sixth Grade Texas Assessment of Academic Skills Scores) and Posttest Achievement (Seventh Grade Texas Assessment of Knowledge and Skills) of Hogg Middle School Students

As shown in Table 9, the analysis of covariance—the analysis that used sixth grade Texas Assessment of Academic Skills mathematics achievement scores as the covariate in examining the seventh grade Texas Assessment of Knowledge and Skills mathematics achievement scores—yielded an F ratio of 9.50 which was statistically significant (p = .003) and an effect size (Δ = +0.79) that was educationally meaningful. The adjusted mean score for the experimental group was 30.21 and the adjusted mean score for the control group was 25.11; the difference between those adjusted means was statistically significant. Therefore, it is reasonable to suggest that the mathematics achievement of the seventh grade students who participated in the Reasoning Mind Pilot Project—as measured by the mathematics section of the Texas Assessment of Knowledge and Skills—is statistically significantly higher than the mathematics achievement of the seventh grade students who did not participate in the Reasoning Mind Pilot Project when sixth grade Texas Assessment of Academic Skills mathematics achievement scores are used as the covariate. Further, the effect size (Δ = +0.79) suggests that this difference is also educationally meaningful. These results are all the more impressive when one notes that the experimental group was exposed to a maximum of only thirty-three hours of instruction between the pretest and the posttest.

Table 10

Results Obtained from Analysis of Covariance of Pretest Achievement (Stanford Achievement Test, Ninth Edition Scores from March 2003) and Posttest Achievement (Seventh Grade Texas Assessment of Knowledge and Skills from May 2003) of Hogg Middle School Students

Analysis of Covariance

Source	Sum of Squares	*df*	Mean Squares	*F*	*p*
Group	149.04	1	149.04	4.13	.047
Pretest	1076.39	1	1076.39	29.81	<.001
Error	1913.77	53	36.11		

Means

		Pretest		Posttest			
Group	*N*	Mean	*SD*	Mean	*SD*	Adjusted Mean	Δ
Experimental	29	10.28	2.83	29.90	7.96	29.32	+0.48
Control	26	9.11	2.58	25.00	6.79	25.98	
Total	55	9.73	2.75	27.58	7.76		

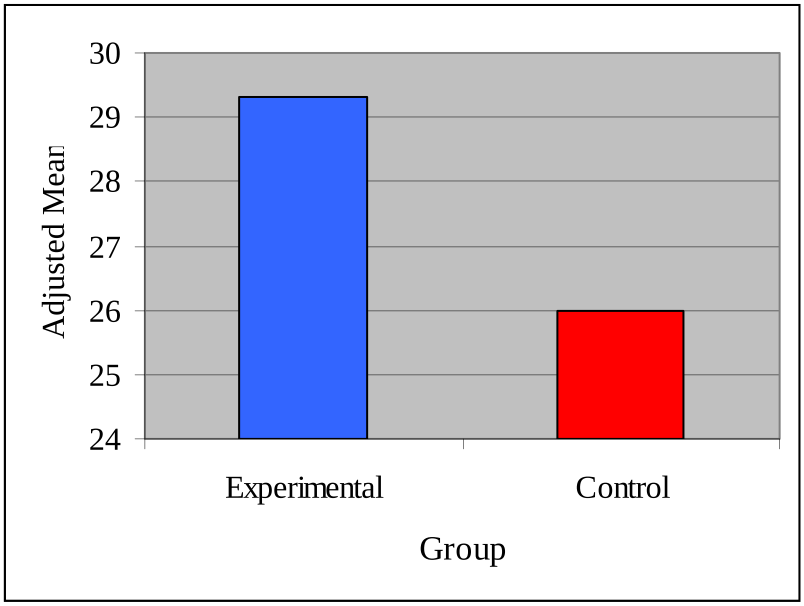


Figure 6

Results Obtained from Analysis of Covariance of Pretest Achievement (Seventh Grade Stanford Achievement Test, Ninth Edition Scores from March 2003) and Posttest Achievement (Seventh Grade Texas Assessment of Knowledge and Skills from May 2003) of Hogg Middle School Students

As shown in Table 10, the analysis of covariance—the analysis that used seventh grade Stanford Achievement Test, Ninth Edition mathematics achievement scores as the covariate in examining the seventh grade Texas Assessment of Knowledge and Skills mathematics achievement scores—yielded an F ratio of 4.13 which was statistically significant (p = .047) and an effect size (Δ = +0.48) that was educationally meaningful. The adjusted mean score for the experimental group was 29.32 and the adjusted mean score for the control group was 25.98; the difference between those two means was statistically significant. Thus, it is clearly reasonable to conclude that the mathematics achievement of the seventh grade students who participated in the Reasoning Mind Pilot Project—as measured by the mathematics section of the Texas Assessment of Knowledge and Skills—is statistically significantly higher than the mathematics achievement of the seventh grade students who did not participate in the Reasoning Mind Pilot Project when seventh grade Stanford Achievement Test, Ninth Edition mathematics achievement scores are used as the covariate. Further, the effect size suggests that this difference is also educationally meaningful. As previously, these results are all the more impressive because the students in the experimental group were exposed to a maximum of only twenty-one hours of instruction between the pretest and the posttest.

While it may have been optimistic to expect that the Reasoning Mind Pilot Project—an instructional system of relatively short duration that limited its focus to mathematical knowledge and skills related to ratios, rates, and proportions—would have a dramatic impact on the total scores on the mathematics section of the state-mandated test, the results suggest that was the case. The results from these two analyses—and those from the four analyses discussed earlier—provide very convincing evidence that the Reasoning Mind Pilot Project was highly effective in improving the mathematics achievement of the seven grade students who participated in the Project.

Student Attitudes

Although the major focus of the Reasoning Mind Pilot Project was on student achievement, the Project also focused on student attitudes—attitudes concerning the learning of mathematics and attitudes concerning the Reasoning Mind system—because research has shown that there is a relationship between student attitudes and student achievement. For example, Thomerson and Smith (1996) argue that, while positive affective experiences are very important in and of themselves, they have been positively correlated to cognitive achievement. Therefore, this study examined the attitudes of the students who participated in the Reasoning Mind Pilot Project—the experimental group.

In an effort to describe student attitudes concerning various aspects of the Reasoning Mind Pilot Project, at the conclusion of the Project, students in the experimental group were administered a simple ten-item questionnaire that asked them to respond to a series of questions. Some of the items were in a "multiple-choice" format while others provided an opportunity for open responses. A copy of the survey is presented in Appendix C. The responses of the students are summarized in the section that follows.

The first item on the survey asked: "Did you like learning math on the RM system?" Students were asked to select from four choices: (1) I liked it *a whole lot*; (2) I liked it; (3) It was O.K.; and (4) I didn't like it at all. Table 11 and Figure 7 on the next page present the results obtained for Item 1.

Table 11

Results Obtained in Response to Item 1. "Did you like learning math on the RM system?"

Response	*N*	Percentage
1. I liked it *a whole lot*.	13	43.33%
2. I liked it.	11	36.67%
3. It was O.K.	5	16.67%
4. I didn't like it at all.	1	3.33%
Total	30	100.00%

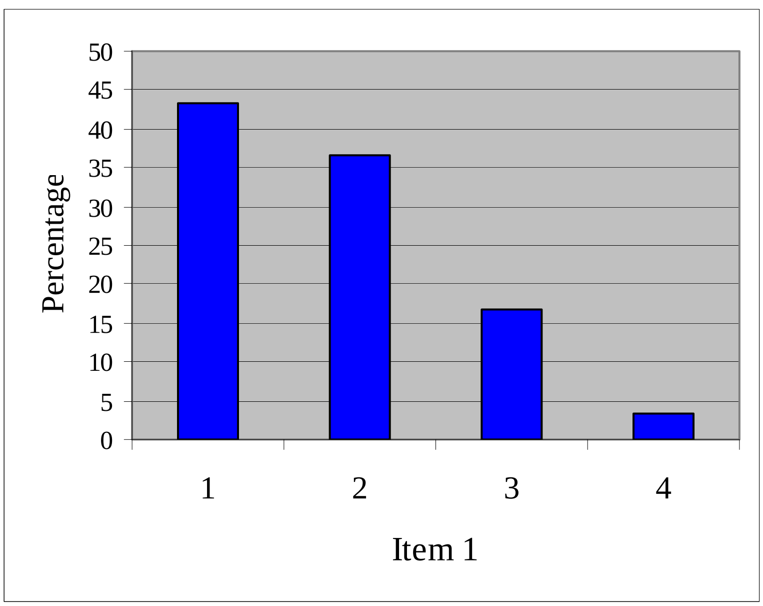


Figure 7

Results Obtained in Response to Item 1. "Did you like learning math on the RM system?"

As shown in Table 11, 43.33% of the students indicated that they liked learning mathematics on the Reasoning Mind system a whole lot while an additional 36.67% of the students indicated that they liked learning mathematics on the Reasoning Mind system. Thus, a total of 80.00% of the students reported that they had positive feelings about learning mathematics on the Reasoning Mind system. Only one student (3.33%) indicated that he or she did not like learning mathematics on the Reasoning Mind system at all. Clearly, an overwhelming majority of the students liked learning mathematics on the Reasoning Mind system.

The second item on the survey asked: "In the future, where would you like to learn math most?" Students were asked to select from three choices: (1) on the RM website; (2) in my regular math class; and (3) it doesn't matter. Table 12 below and Figure 8 on the next page present the results obtained for Item 2.

Table 12

Results Obtained in Response to Item 2. "In the future, where would you like to learn math most?"

Response	*N*	Percentage
1. On the RM website	16	53.33%
2. In my regular math class	2	6.67%
3. It doesn't matter	12	40.00%
Total	30	100.00%

As shown in Table 12, 53.33% of the students—a majority of the students—indicated that, in the future, they would like to learn mathematics on the Reasoning Mind website. Only two students (6.67%) indicated that, in the future, they would like to learn mathematics in their regular mathematics classes. The remaining 40.00% indicated that it did not matter. This supports the conclusions drawn from student responses to the first item: a majority of the students preferred the Reasoning Mind system.

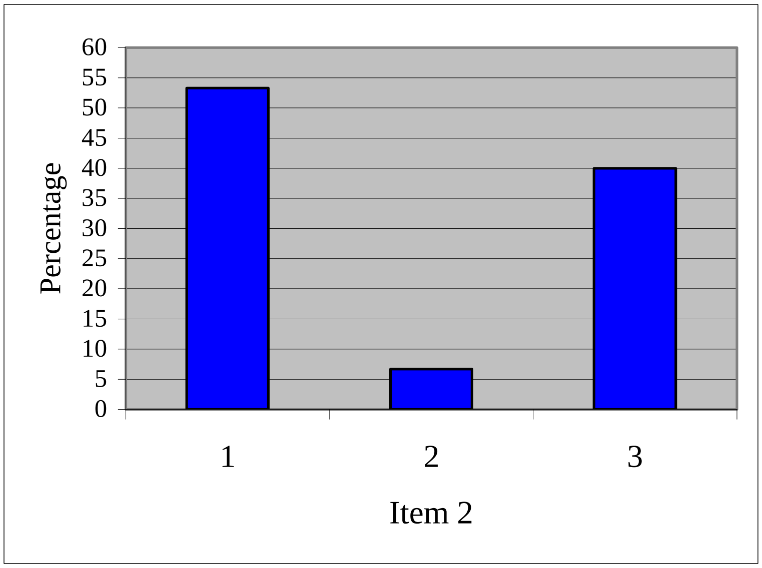


Figure 8

Results Obtained in Response to Item 2. "In the future, where would you like to learn math most?"

The third item on the survey asked: "Which class was harder this semester?" Students were asked to select from five choices: (1) The RM class was *much* harder than the regular class; (2) the RM class was harder than the regular class; (3) they were about the same; (4) my regular math class was harder than RM; and (5) my regular math class was *much* harder than RM. Table 13 and Figure 9 present the results obtained for Item 3.

Table 13

Results Obtained in Response to Item 3. "Which class was harder this semester?"

Response	*N*	Percentage
1. The RM class was *much* harder than the regular class.	1	3.33%
2. The RM class was harder than the regular class.	9	30.00%
3. They were about the same.	9	30.00%
4. My regular math class was harder than RM.	9	30.00%
5. My regular math class was *much* harder than RM.	2	6.67%
Total	30	100.00%

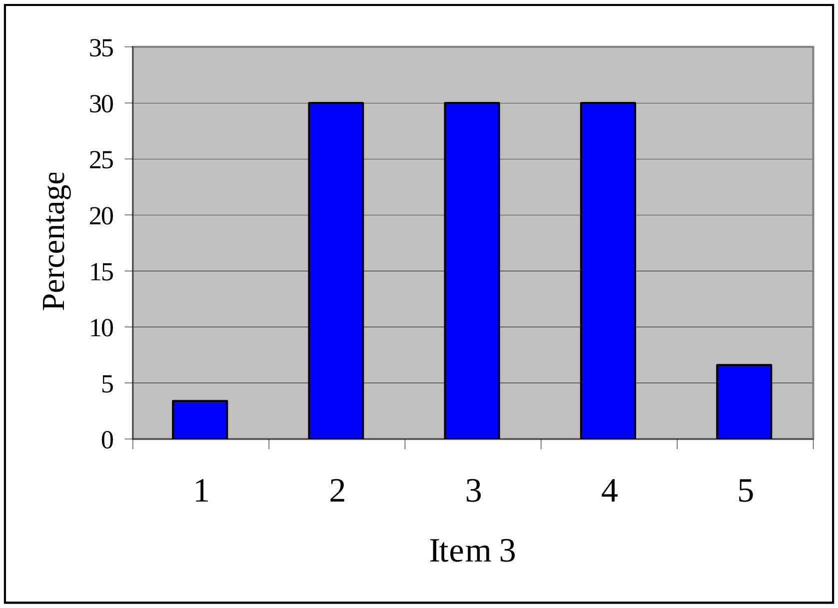


Figure 9

Results Obtained in Response to Item 3. "Which class was harder this semester?"

As shown in Table 13, 30.00% of the students indicated that they thought the Reasoning Mind class was harder than their regular mathematics class, 30.00% of the students indicated that they thought the Reasoning Mind class and their regular mathematics class were about the same, and 30.00% of the students indicated that they thought their regular mathematics class was harder than the Reasoning Mind class. Thus, no clear consensus emerged from these results. However, it should be noted that only one student indicated that he or she thought the Reasoning Mind class was much harder than his or her regular mathematics class.

The fourth item on the survey asked: "Where have you learned more math this semester?" Students were asked to select from five choices: (1) I learned *much* more in RM than in my regular class; (2) I learned more in RM than in my regular class; (3) I learned about the same; (4) I learned more in my regular math class than in RM; and (5) I learned *much* more in my regular math class than in RM. Table 14 and Figure 10 on the next page present the results obtained for Item 4.

As shown in Table 14, 40.00% of the students indicated that they learned much more in the Reasoning Mind class than in their regular mathematics classes and 30.00% indicated that they learned more in the Reasoning Mind class than in their regular mathematics classes. Thus, a total of 70.00% of the students reported that they learned more in the Reasoning Mind class than in their regular mathematics classes. Only three students (10.00%) indicated that they learned more or much more in their regular mathematics classes than in the Reasoning Mind class. A clear majority of the students

Table 14

Results Obtained in Response to Item 4. "Where have you learned more math this semester?"

Response	*N*	Percentage
1. I learned *much* more in RM than in my regular class.	12	40.00%
2. I learned more in RM than in my regular class.	9	30.00%
3. I learned about the same.	6	20.00%
4. I learned more in my regular math class than in RM.	2	6.67%
5. I learned *much* more in my regular math class than in RM.	1	3.33%
Total	30	100.00%

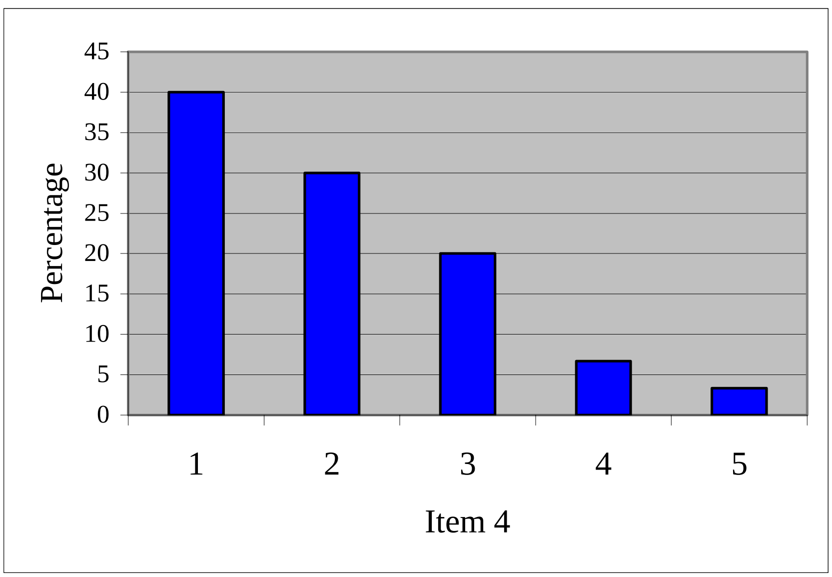


Figure 10

Results Obtained in Response to Item 4. "Where have you learned more math this semester?"

felt that they learned more in the Reasoning Mind class than in their regular mathematics classes.

The fifth item asked the students to respond to two open-ended questions: (1) "What did you like *most* about learning math on the RM website?" and (2) "What else did you like about RM?" The responses of the students to the first of these questions are presented below.

Student 1. "The most thing that I learned math and enjoy was the gameroom."

Student 2. "The gifts."

Student 3. "When the Genie after the question gave me a solution so that I could understand it better."

Student 4. "You don't have to use paper or pencil."

Student 5. "It was on the computer."

Student 6. "Ratios."

Student 7. "That we got to redeem our points."

Student 8. "I like that it was on a computer and liked that you could play math games."

Student 9. "I enjoyed the problems that were given and the games."

Student 10. "Quick sessions."

Student 11. "The way the Genie helps you."

Student 12. "I learned new things on the RM."

Student 13. "I didn't like it."

Student 14. "That they *show* you how you're supposed to do it."

Student 15. "I loved the problems that they gave me and I also learned a lot by this system. If it wasn't for this class I wouldn't be as smart as I am."

Student 16. "I like reducing fractions in the RM website."

Student 17. "I liked the games, animations, and the most interesting thing was the points."

Student 18. "I like that you can get help from tutors when you have a problem."

Student 19. "I could understand it better than my teacher."

Student 20. "The games."

Student 21. "Doing it on a computer."

Student 22. "Playing games."

Student 23. "I liked that there were references to look up instead of asking. The tutors were the best because they helped me with problems."

Student 24. "Getting awards and prizes."

Student 25. "What I liked most about learning math on the RM website is when you get the correct answer the Genie did something funny."

Student 26. "I liked the ratios cause it was easy."

Student 27. "That there were tutors there to help us."

Student 28. "I liked the games and the way of teaching."

Student 29. "Nothing."

Student 30. "That the program explained and gave examples."

The second part of the fifth item asked the students: "What else did you like about RM?" The responses of the students to this question are presented below.

Student 1. "I liked the classrooms."

Student 2. "We could use the computers."

Student 3. "I like when I get prizes."

Student 4. "You can use the computer."

Student 5. "It was very entertaining."

Student 6. "Genie."

Student 7. "That there are games."

Student 8. "That the main teacher, the RM Genie, was a cartoon."

Student 9. "I also enjoyed being challenged."

Student 10. "How much fun I had."

Student 11. "The games."

Student 12. "There is no teacher."

Student 13. "Nothing."

Student 14. "I get to play games with friends."

Student 15. "I got to play the Dino Island and it was really cool."

Student 16. "Having my own e-mail."

Student 17. "I liked the time when you get prizes."

Student 18. "It was very fun."

Student 19. "That we got prizes."

Student 20. "The tutors."

Student 21. "Prizes."

Student 22. "Playing Dinosaur Island."

Student 23. "I liked the games."

Student 24. "It's math on the computer."

Student 25. "I learned a lot of stuff about RM like that helps kids in math."

Student 26. "The way it explained the solutions."

Student 27. "That we could get prizes for how much we learned."

Student 28. No response.

Student 29. "Nothing."

Student 30. "That we got prizes."

Student responses to the fifth item indicated that the students liked a wide variety of things about "learning math on the RM website." The things the students most often mentioned included: the games; the prizes, rewards, and gifts; the assistance provided by the tutors; learning on a computer; and learning mathematics.

The sixth item asked the students to respond to two open-ended questions: (1) "What did you like *least* about learning math on the RM website?" and (2) "What else did you dislike about RM?" The responses of the students to the first of these questions are presented below.

Student 1. "I didn't like some hard problems that you couldn't understand and were wrong."

Student 2. "They were all on our back wanting us to finish."

Student 3. "Nothing."

Student 4. "The problems were difficult."

Student 5. "Being pulled out of guided study to work with a tutor that's annoying."

Student 6. "Nothing."

Student 7. "The errors that occurred."

Student 8. "That some times the work would get hard."

Student 9. "One errors."

Student 10. "We only have one and a half hours of class."

Student 11. "The computer problem."

Student 12. "Some of the problems are too hard."

Student 13. "What I liked least was sourdough the problems."

Student 14. "Problems sometimes were too hard."

Student 15. "Sometimes the problems were too hard to do and to understand."

Student 16. "The test questions were really hard."

Student 17. "I didn't like the questions that were too hard."

Student 18. "We had to work everyday."

Student 19. "I didn't like to read all the things Genie said."

Student 20. "The hard problems."

Student 21. "No free time."

Student 22. "Doing level C problems in the guided study."

Student 23. "I didn't like that some of the problems were really hard."

Student 24. "Nothing."

Student 25. "That there were some really hard problems."

Student 26. "Some of the problems."

Student 27. “Not being able to chat with friends.”

Student 28. “That you don’t get to talk with other students about every answer.”

Student 29. “Everything.”

Student 30. “That we always worked on the computer and my eyes hurt.”

The second part of the sixth item asked the students: “What else did you dislike about RM?” The responses of the students to this question are presented below.

Student 1. “I didn’t dislike anything else.”

Student 2. “We had to stay on it all day.”

Student 3. No response.

Student 4. “It’s boring.”

Student 5. “Needs to give more points; some problems were pretty hard and I only got like five points when I should have gotten seven.”

Student 6. “Nothing.”

Student 7. “Guided study.”

Student 8. “That sometimes the system would mess up.”

Student 9. “Nothing.”

Student 10. “Dino Island.”

Student 11. “The errors.”

Student 12. “The tests.”

Student 13. “That there was no type of action.”

Student 14. “Some of the teachers were very bad/angry when I had problems and had to get out.”

Student 15. “Sometimes the problems were too hard to do and to understand.”

Student 16. “Sometime we had a hard time to log in.”

Student 17. “Nothing else.”

Student 18. “Nothing else.”

Student 19. “It was a little hard to explain.”

Student 20. “Level of problems.”

Student 21. “No free time.”

Student 22. “Getting a lot of problems wrong.”

Student 23. “I didn’t like that you had to finish Guided Study before you got games.”

Student 24. “Nothing.”

Student 25. “That sometimes if we were going wrong we had to go to a tutor but the tutor that I got was patient with me.”

Student 26. “It took time to download solutions.”

Student 27. “In the game room you can’t get any points.”

Student 28. No response.

Student 29. “Everything.”

Student 30. “We had no free time.”

Student responses to the sixth item indicated that there were a number of things the students liked “*least* about learning math on the RM website.” The two things the students most often mentioned were: the difficulty of the problems and the tests; and the lack of free time.

The seventh item also asked the students to respond to two open-ended questions: (1) “How much time did you spend with the RM system outside of class?” and (2) “Do you have access to a computer outside of school that works with RM?” The responses of the students to the first of these questions are presented below.

Student 1. “None.”

Student 2. “I don’t use it at home.”

Student 3. “Nothing.”

Student 4. “I didn’t spend any time.”

Student 5. “Some, fairly a lot but I play games more than guided study.”

Student 6. “None.”

Student 7. “0 times.”

Student 8. “One or two during a week.”

Student 9. “I’m not too sure.”

Student 10. “Three.”

Student 11. “Not that much.”

Student 12. “Don’t know.”

Student 13. “None.”

Student 14. “None.”

Student 15. “I have a friend that has a computer and when I go to her class, I always go to RM to have more points.”

Student 16. “A few hours; one to two hours; not that much.”

Student 17. “I did RM once at my house.”

Student 18. “I did not spend much time.”

Student 19. “I didn’t spend time with RM at home.”

Student 20. “None.”

Student 21. “At home.”

Student 22. “A little at my house.”

Student 23. “I haven’t.”

Student 24. “One semester.”

Student 25. “No time.”

Student 26. “I don’t have a computer at home.”

Student 27. “The second semester of the school year.”

Student 28. “None.”

Student 29. “None.”

Student 30. “I didn’t.”

The second part of the seventh item asked the students: “Do you have access to a computer outside of school that works with RM?” The responses of the students to this question are presented below.

Student 1. “No.”

Student 2. “I have a computer; I just don’t get on that program.”

Student 3. “No.”

Student 4. “Yes.”

Student 5. “Yes.”

Student 6. “No.”

Student 7. “Yes.”

Student 8. “Yes.”

Student 9. “Yes.”

Student 10. “No.”

Student 11. “No.”

Student 12. “Yes.”

Student 13. “Yeah!”

Student 14. “No.”

Student 15. “Yes, my friend’s computer worked with RM but now it doesn’t.”

Student 16. “Yes.”

Student 17. “Yes.”

Student 18. “No.”

Student 19. “No.”

Student 20. “No.”

Student 21. “No.”

Student 22. “Yes.”

Student 23. “Yes.”

Student 24. “Yes.”

Student 25. “I didn’t use it.”

Student 26. “No.”

Student 27. “No.”

Student 28. “No.”

Student 29. “No.”

Student 30. “No.”

Student responses to the two questions asked in the seventh item suggested that most of the students did not spend time with the Reasoning Mind system outside of class—most probably because most did not have access to a computer outside of school that worked with the system.

The eighth item on the survey asked: “How did your liking of math change after the RM class?” Students were asked to select from five choices: (1) Now, I like math *a whole lot* more than before; (2) Now, I like math more than before; (3) I like math the same as before; (4) Now, I like math less than before; and (5) Now, I like math *a whole lot* less than before. Table 15 below and Figure 11 on the next page present the results obtained for Item 8.

Table 15

Results Obtained in Response to Item 8. “How did your liking of math change after the RM class?”

Response	*N*	Percentage
1. Now, I like math *a whole lot* more than before.	2	6.67%
2. Now, I like math more than before.	15	50.00%
3. I like math the same as before.	12	40.00%
4. Now, I like math less than before.	0	0.00%
5. Now, I like math *a whole lot* less than before.	1	3.33%
Total	30	100.00%

As shown in Table 15, 6.67% of the students indicated that they liked mathematics a whole lot more after participating in the Reasoning Mind class and 50.00% indicated that they liked mathematics more after participating in the Reasoning Mind class. Thus, a majority of the students (56.67%) reported that their attitudes toward mathematics were more positive after participating in the Reasoning Mind class than before participating in the Reasoning Mind class. Only one student (3.33%) indicated that his

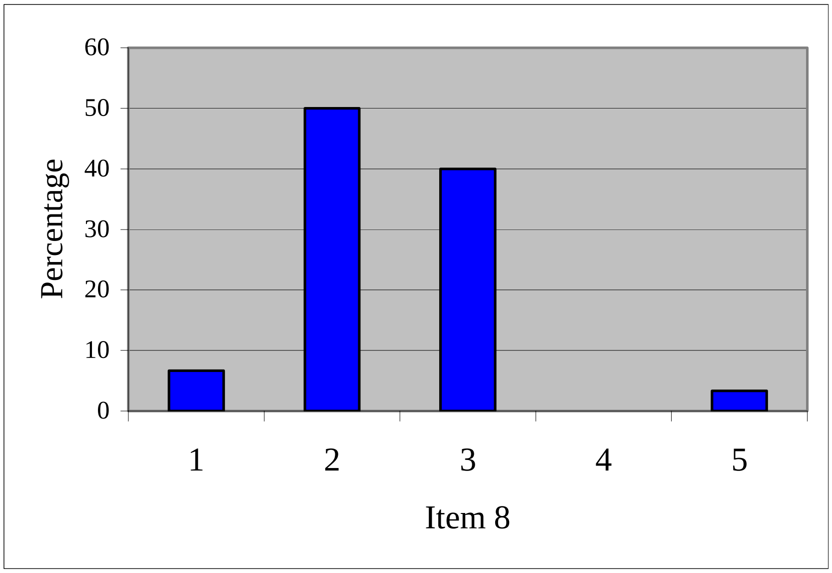


Figure 11

Results Obtained in Response to Item 8. "How did your liking of math change after the RM class?"

or her attitude toward mathematics was more negative after participating in the Reasoning Mind class than before participating in the Reasoning Mind class. On average, the students reported that participation in the Reasoning Mind class improved student attitudes toward the study of mathematics.

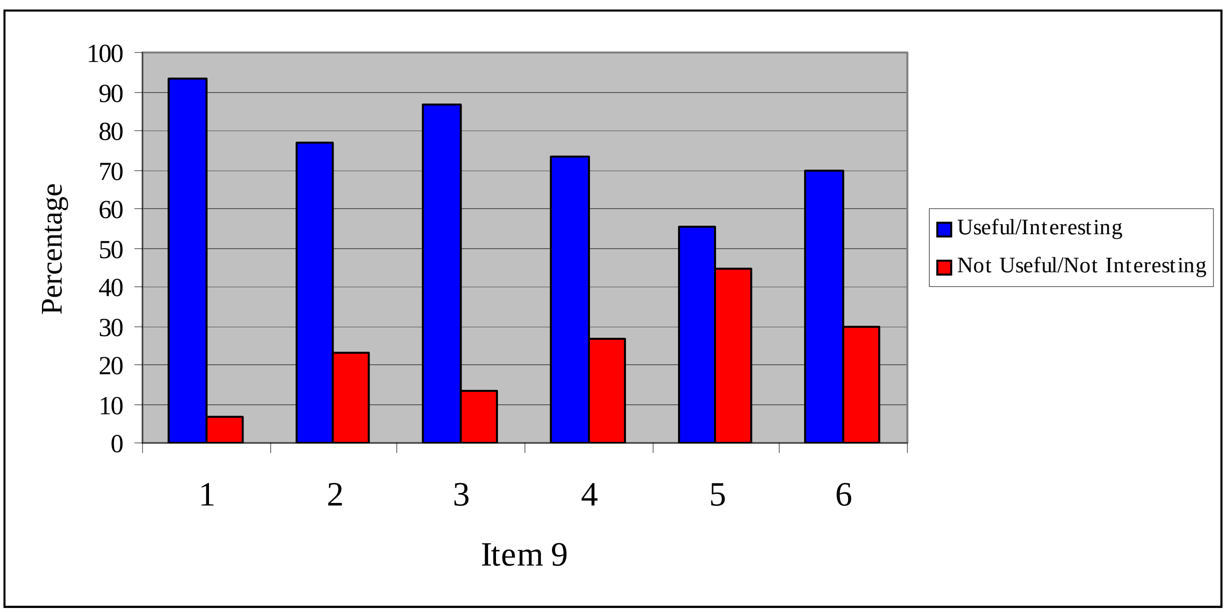
The ninth item on the survey provided the students with a listing of six Reasoning Mind activities—Guided Study, Independent Study, Classrooms, Problem Solving Games, Dino Island Game, and E-mails to and from the Genie—and asked the students to respond to the following question: "Which of the following activities on the RM website did you find useful or interesting?" Table 16 and Figure 12 on the next page present the results obtained for Item 9.

As shown in Table 16, 93.33% of the students reported that Guided Study was useful and interesting, 76.67% of the students reported that Independent Study was useful and interesting, 86.67% of the students reported that Classrooms were useful and interesting, 73.33% of the students reported that the Problem Solving Games were useful and interesting, 55.17% of the students reported that the Dino Island Game was useful and interesting, and 70.00% of the students reported that the E-mails to and from the Genie were useful and interesting. Even the lowest rated of the activities—the Dino Island Game—was viewed by a majority of the students as a useful and interesting activity. Thus, it seems clear that, on the whole, the students viewed each of the six activities as useful and interesting.

Table 16

Results Obtained in Response to Item 9. "Which of the following activities on the RM website did you find useful or interesting?"

	Useful/Interesting		Not Useful/Not Interesting	
Activity	*N*	Percentage	*N*	Percentage
Guided Study	28	93.33%	2	6.67%
Independent Study	23	76.67%	7	23.33%
Classrooms	26	86.67%	4	13.33%
Problem Solving Games	22	73.33%	8	26.67%
Dino Island Game	16	55.17%	13	44.83%
E-Mails to and from the Genie	21	70.00%	9	30.00%



The last of the items on the survey, Item 10, asked: "Is there anything else you'd like to say about RM?" The student's responses are presented below.

Student 1. "It's a better way of learning math."

Student 2. “It was an O.K. game and it was fun. I would get in this class again if there was something that I would get out of it, like go on the Internet.”

Student 3. “It is great.”

Student 4. No response.

Student 5. “It was really cool and I enjoyed it a lot.”

Student 6. “I wish I can take it next year.”

Student 7. “Yes, that we should have it next year.”

Student 8. “I hope that it continues on and on so that other kids could have as much fun learning as we did.”

Student 9. “It was very fun.”

Student 10. “No.”

Student 11. “Yes, it’s been great working with RM.”

Student 12. No response.

Student 13. “Nothing really.”

Student 14. No response.

Student 15. “It is cool and you can learn a lot from it.”

Student 16. “RM is a really cool website and it really helped me in my math. I got to learn many things. I had a great time.”

Student 17. “I would like to work with it next year.”

Student 18. “This is a very good website.”

Student 19. “I think the games have to be more fun.”

Student 20. “I hope you stay at Hogg and you teach eighth grade.”

Student 21. “No.”

Student 22. “No.”

Student 23. “It helped improve my math.”

Student 24. “Yes. It’s a good class.”

Student 25. “My favorite tutor was Ms. Khadeyeva. She was nice and I liked RM a lot for the problems and especially for the prizes.”

Student 26. “It was a good website.”

Student 27. “No.”

Student 28. “It’s a good program to work in.”

Student 29. “No.”

Student 30. “Yes, that I’ll miss the program and the teachers.”

Student responses to the last item indicated that the students thought the Reasoning Mind system was effective in helping them learn mathematics and was fun; several also indicated that they hoped that the program would continue next year.

Clearly, the results obtained from the student questionnaire indicated that students who experienced the program—the students in the experimental group—were very positive about their experiences.

Teacher Perceptions

In an effort to describe the attitudes of the teachers of the students who participated in the Reasoning Mind Pilot Project, a short questionnaire was administered to those teachers—Ms. Kelli Wadley, Chairperson of the Hogg Middle School Mathematics Department, and Ms. Lakeisha Washington, a mathematics teacher at Hogg Middle School. A copy of the survey is presented in Appendix D. The survey contained three items:

1. In your opinion, were the students engaged and interested in the RM class? Please explain.
2. Do you think RM is good for the students? Do you believe it could be a useful tool for teachers like you?
3. Is there anything else you'd like to say about RM?

The comments of the teachers in response to the first item are provided below:

> K. W. “I found that the students were engaged and eager to work with the system. They seemed especially fond of the genie and many enjoyed working with the tutors. There was very little off-task behavior because the students were engaged and motivated with the program.”

> L. W. “Most of the students were actively engaged and interested in the RM Program. I noticed that some of the students improved in their regular math class which I believe stems from the RM Program.”

The comments of the teachers in response to the second item are provided below:

> K. W. “I think anything that captures students’ interests and gets them excited about Math is a good tool. It is good for teachers because it is a way to “hook” those students that are hesitant about doing Math and challenges them once they are working in the program.”

> L. W. “I think it is a great program. However, I don’t feel it is a program for all students. The students that lack motivation and/or drive will not benefit from this type of program because they can’t stay focused.”

The comments of the teachers in response to the third item are provided below:

> K. W. “RM is a unique program that grasps the students attention and gets them motivated to work challenging math problems.”

> L. W. “Great concept, great program!”

The responses provided by the teachers of the students who participated in the Reasoning Mind Pilot Project indicate that they both viewed the Reasoning Mind program as effectively engaging students in the study of mathematics and that their students both enjoyed and benefited from participation in the program. Clearly, both teachers like what the program had done for their students.

References

Diederich, P. A. *Short-Cut Statistics for Teacher-Made Tests*. Princeton, New Jersey: Educational Testing Service, 1973.

Gall, M. D., J. P. Gall, and W. R. Borg. *Educational Research: An Introduction*. Boston, Massachusetts: Allyn-Bacon Publishing Company, 2003.

Marshall, J. C., and L. W. Hales. *Classroom Test Construction*. Reading, Massachusetts: Addison-Wesley Publishing Company, 1971.

Thomerson, J. D., and Smith, C. L. Student Perceptions of the Affective Experiences Encountered in Distance Learning Courses. *The American Journal of Distance Education*, 10 (3), 1996, pages 37-48.

Sax, G., with J. W. Newton. *Principles of Educational and Psychological Measurement and Evaluation*. Belmont, California: Wadsworth Publishing Company, 1997.

Appendixes

Appendix A

Reasoning Mind 2003 Pretest
Reasoning Mind 2003 Posttest

RM2003 Pretest

Grade: _______

School: ____

Student name: ____

Date: ______________________

Solve each problem. Depending on the problem, you should:

- Circle the letter corresponding to the correct answer, like this: **(B)**
- Enter your number answer in a box, like this: [3.4]
- Enter your answer as a common fraction, like this: $\boxed{\frac{3}{4}}$

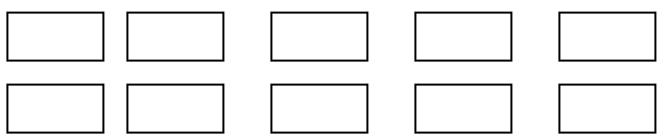
1.

Find the ratio of 3 baseballs to 5 baseballs and write it as a fraction.

Answer:

2.

There are 10 rectangles on the picture. Shade the right number of rectangles to make the ratio of shaded rectangles to unshaded ones 2:3. In addition, write the number of shaded rectangles in the answer box.

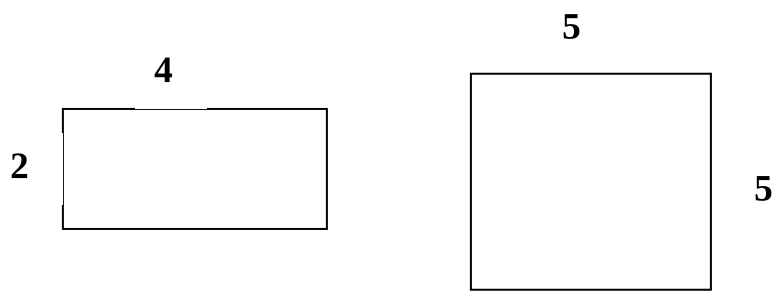


Answer:

GO ON

3.

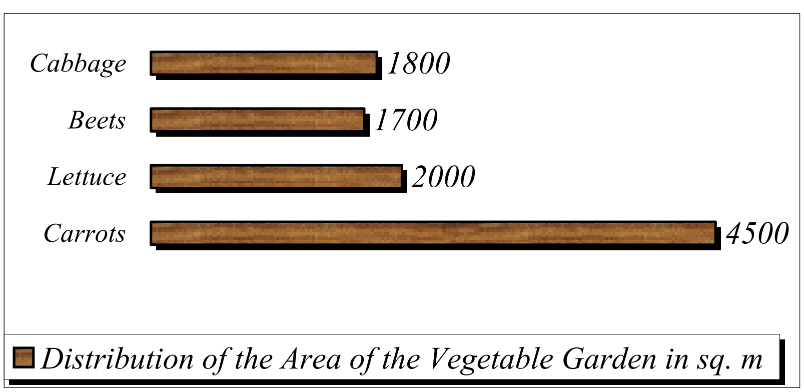
Find the ratio of the perimeter of the rectangle to the perimeter of the square. Give your answer as a common fraction in simplest form.



Answer:

4.

Joseph has a vegetable garden. Find the ratio of the area of the garden taken up by cabbage to the area of the garden taken up by lettuce. Give your answer as a common fraction in simplest form.

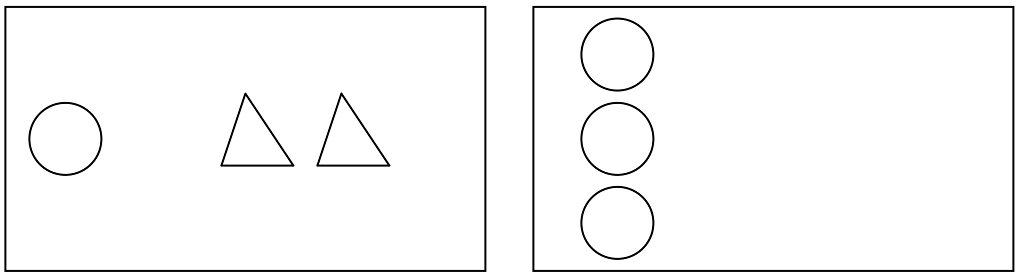


Answer:

GO ON

5.

How many triangles should be drawn in the second box to make the ratio of circles to triangles in the second box the same as in the first box?



Answer: ☐ triangles

6.

The table shows the dimensions of some asteroids. Using the table, find the ratio of the depth of the biggest crater of Fulcros to the depth of the biggest crater of PH-4G. Give your answer as a common fraction in simplest form.

Name of Asteroid	*Length*	*Width*	*Depth of biggest crater*
Small Berlit	*115km*	*11km*	*11 m*
PH-4G	*30km*	*750m*	*35 m*
Gibraltar	*59km*	*14km*	*55 m*
Dardanus	*120km*	*1300m*	*30 m*
Fulcros	*650km*	*80km*	*0.15 km*
Orintos	*55km*	*200km*	*1.28 km*
La Trapa	*578km*	*32km*	*25 m*
Greater Berlit	*125km*	*500m*	*12 m*

Answer:

GO ON

7.

To paint a wall of surface area S m^2, you need T hours. What does the ratio of S to T show?

A How long it takes to paint 1 m^2.

B What part of the wall can be painted in T hours.

C The surface area that can be painted in 1 hour.

D The amount of time needed to paint the whole wall.

8.

Find the ratio of 3 ft^2 to 9 in^2. Express your answer as a whole number.

Answer: $\square$

9.

Given the equality $2 \times 15 = 10 \times 3$, create a correct proportion using the numbers 2, 3, 10, and 15.

Answer: $\frac{\square}{\square} = \frac{\square}{\square}$

GO ON

10.

Using 8 manufacturing machines, Factory A produces 1,200 parts per day. How many machines are there in Factory B if it produces 1,050 parts per day, given that both factories work the same number of hours per day and use the same type of machines?

Answer: ☐ machines

11.

Use two of the four given ratios to set up a correct proportion. Select one of the answer choices.

$Ratio\ \#1:\ \frac{28}{4}$

$Ratio\ \#2:\ \frac{24}{4}$

$Ratio\ \#3:\ \frac{21}{3}$

$Ratio\ \#4:\ \frac{35}{7}$

A Ratio #1 = Ratio #2

B Ratio #2 = Ratio #3

C Ratio #1 = Ratio #3

D Ratio #2 = Ratio #4

E Ratio #2 = Ratio #4

F Ratio #3 = Ratio #4

GO ON

12.

A room is 60 feet long. What is its length in inches on a picture, if it is drawn with a scale factor of 1 inch to 20 feet?

Answer: ☐ inches

13.

Set up a proportion using the following numbers: 36, 6, 9, 24.

Answer: $\frac{\square}{\square} = \frac{\square}{\square}$

14.

In order to cover 10 sq. m of walls, 5 rolls of wallpaper were used. How many rolls of wallpaper would it take to cover 28 sq. m?

Answer: ☐ rolls

15.

Convert 24 inches per second into feet per minute.

Answer: ☐ feet/minute

GO ON

16.

Write the ratio of 0.45 to 0.27 as a fraction and reduce it to simplest form.

Answer: $\frac{\square}{\square}$

17.

Find and write two two-digit whole numbers whose ratio is 7.

Answer:

The first number is: $\square$

The second number is: $\square$

18.

Find the scale of a map if a segment of 5 cm on the map corresponds to a real distance of 80 km. Write your answer in the form of a ratio 1 : X, showing how many centimeters in reality correspond to 1 cm on the map.

Answer: The scale of the map is 1 : $\square$

19.

Solve the equation: $\frac{2.4}{x} = \frac{2.1}{2.8}$

Answer: x = $\square$

GO ON

20.

What is the price of 3.2 m of ribbon if 1.2 m costs $6.12?

Answer: [ ]

21.

One kilogram of scrap metal can be recycled to replace 2.5 kg of iron ore. How much iron ore can be replaced by 4,000 kg of scrap metal?

Answer: [ ] kg

22.

In order to dig a ditch 150 cm deep, an excavator is used that digs a 450-meter-long ditch in 5 hours. Which proportion can be used to find *t* – the time needed to dig a 2520-meter long ditch of the same depth?

A. $\frac{5}{t} = \frac{450}{2520}$ **B**. $\frac{t}{5} = \frac{450}{2520}$ **C**. $\frac{5}{2520} = \frac{450}{t}$ **D**. $\frac{5}{2520} = \frac{150}{t}$.

23.

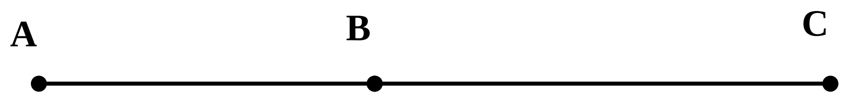
Joe Dassain was on a road trip for one week. Every day, he drove for 6 hours. What speed was he driving at, if he traveled 4200 miles?

Answer: [ ] miles/hour

GO ON

24.

Find the length of segment AC if the length of segment AB is equal to 16 inches and the ratio of the length of AB to the length of BC is equal to 0.8.



Answer: ☐ inches

25.

Every fourth citizen of city A is a child, and every third citizen of city B is a child. On a holiday, each child got some balloons. Find the ratio of number of balloons bought in city A to the number of balloons bought in city B. Give your answer as a common fraction in simplest form.

Population of Cities A, B, and C

	City A	City B	City C
Population	36,000 ppl.	48,000 ppl.	24,000 ppl.

Number of the Balloons Bought for Each Child

	City A	City B	City C
Yellow balloons	1	2	1
Green balloons	0	0	3
Red balloons	2	3	1
Blue balloons	1	0	2

Answer: ☐

GO ON

26.

From these ratios, select the one that shows the price of 1 unit of merchandise. Then, imagine that the merchandise drops in price. Find the new price of one unit if, for the same cost as in the ratio you selected from below, you can now buy one more unit.

I. $\frac{\text{52 m}}{\text{6 units}}$

II. $\frac{\$42}{\text{6 units}}$

III. $\frac{\$42}{\text{2 km}}$

IV. $\frac{\text{6 units}}{\$42}$

Answer: ☐ per unit

27.

You have 2 similar paper rectangles. The perimeter of the first one is 32 cm, and the perimeter of the second one is 160 cm. Find the lengths of the sides of the rectangles if the width of the second rectangle is 35 cm.

Answer:

The length of the first rectangle is ☐ cm.

The length of the second rectangle is ☐ cm.

GO ON

28.

Two rectangles are similar. The area of the first one is 28 sq. in. Find the area of the second rectangle if the ratio of its length to the first rectangle's length is 2.

Answer: ☐ sq. in.

29.

Solve the equation: $\frac{4y+5}{18}=\frac{8}{9}$

Answer: y = ☐

30.

On a map, the distance between two towns is 15 cm. The scale of the map is 1:8,000,000. A group of tourists traveled from the first town to the other in two days. On the first day, they traveled 700 kilometers. What distance did they travel on the second day? Give the answer in kilometers.

Answer: ☐ km.

GO ON

31.

7 pumps can pump all of the water out of a swimming pool in 20 hours. How many more pumps would you need to pump all of the water out in 14 hours?

Answer: ☐ more pumps.

32.

Find the values of three numbers if the ratio of the first number to the second one is 5:3, and the ratio of the second to the third is 2:5. You also know that their mean is 31.

Answer:

The first number is ☐

The second number is ☐

The third number is ☐

STOP

RM2003 Post Test

Grade: _______

School: ____

Student name: ____

Date: _____________________

Solve each problem. Depending on the problem, you should:

- Circle the letter corresponding to the correct answer, like this: (**B**)
- Enter your number answer in a box, like this: [3.4]
- Enter your answer as a common fraction, like this: [$\frac{3}{4}$]

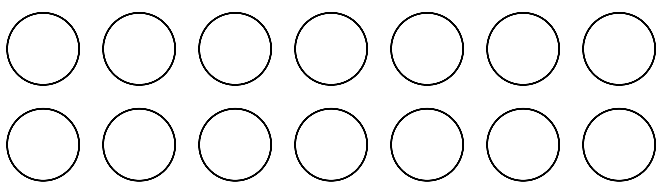
1.

Find the ratio of 7 cups to 9 cups and write it as a fraction.

Answer:

2.

There are 14 circles on the picture. Shade the right number of circles to make the ratio of shaded circles to unshaded ones 3:4. In addition, write the number of shaded circles in the answer box.

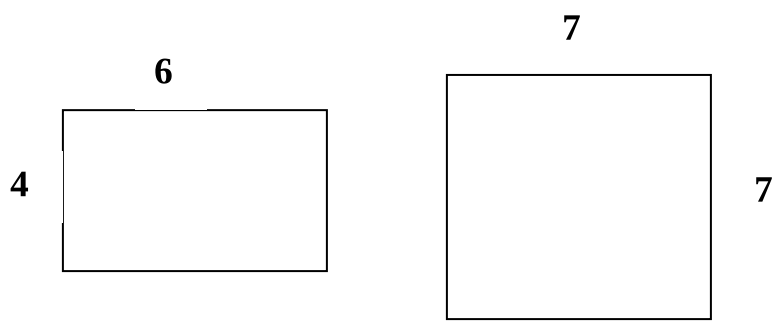


Answer:

GO ON

3.

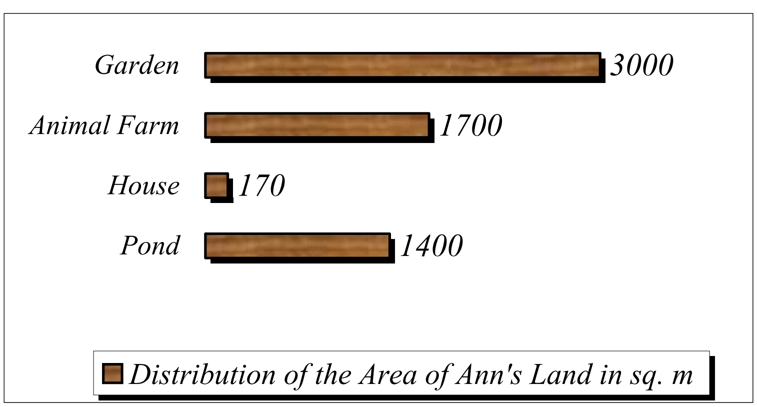
Find the ratio of the perimeter of the rectangle to the perimeter of the square. Give your answer as a common fraction in simplest form.



Answer: $\frac{\square}{\square}$

4.

Ann lives on a piece of land. Find the ratio of the area of Ann's land taken up by the pond to the area of the land taken up by the garden. Give your answer as a common fraction in simplest form.

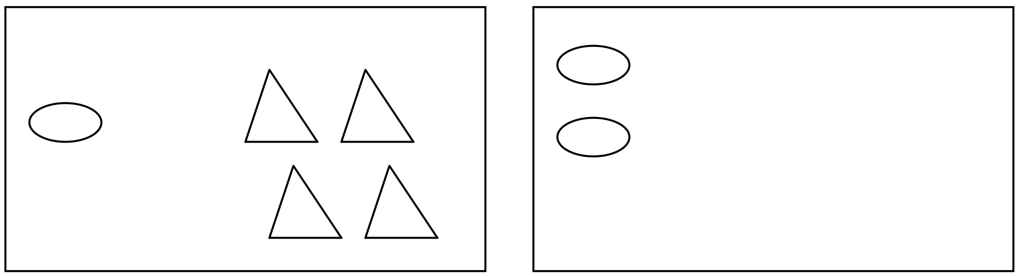


Answer: $\frac{\square}{\square}$

GO ON

5.

How many triangles should be drawn in the second box to make the ratio of ovals to triangles in the second box the same as in the first box?



Answer: ☐ triangles

6.

This table shows the diameters of some planets, the heights of their mountains and depths of their lakes. Using the table, find the ratio of the depth of the biggest lake of Gonzar to the depth of the biggest lake of Jupiker. Give your answer as a common fraction in simplest form.

Name of Planet	*Diameter*	*Height of largest mountain*	*Depth of biggest lake*
Small Lodd	*3524 km*	*11.7 km*	*11 m*
PH-4S	*4845 km*	*750 m*	*35 m*
Jupiker	*1379 km*	*5.2 km*	*45 m*
Dardanus	*8657 km*	*1300 m*	*30 m*
Gonzar	*7551 km*	*12.6 km*	*0.35 km*
Orintos	*7741 km*	*13.8 km*	*1.28 km*
La Tukka	*2310 km*	*560 m*	*25 m*
Greater Lodd	*5932 km*	*14.5 km*	*12 m*

Answer: ☐

GO ON

7.

It takes T hours to pave a parking lot of surface area S m^2. What does the ratio of S to T show?

A How long it takes to pave 1 m^2.

B The surface area that can be paved in 1 hour.

C What part of the parking lot can be paved in T hours.

D The amount of time needed to pave the whole parking lot.

8.

Find the ratio of 4 ft^2 to 8 in^2. Express your answer as a whole number.

Answer: ☐

9.

Given the equality $3 \times 16 = 8 \times 6$, create a correct proportion using the numbers 3, 6, 8, and 16.

Answer: $\frac{\square}{\square} = \frac{\square}{\square}$

GO ON

10.

Using 9 stoves, Restaurant A cooks 1,350 burgers per day. How many stoves are there in Restaurant B if it cooks 1,200 burgers per day, given that the kitchens at both restaurants work the same number of hours per day and use the same type of stoves?

Answer: ☐ stoves

11.

Use two of the four given ratios to set up a correct proportion. Select one of the answer choices.

$Ratio\,\#1:\ \frac{28}{4}$

$Ratio\,\#2:\ \frac{36}{6}$

$Ratio\,\#3:\ \frac{21}{7}$

$Ratio\,\#4:\ \frac{35}{5}$

A Ratio #1 = Ratio #2

B Ratio #2 = Ratio #3

C Ratio #1 = Ratio #3

D Ratio #1 = Ratio #4

E Ratio #2 = Ratio #4

F Ratio #3 = Ratio #4

GO ON

12.

A swimming pool is 90 feet long. What is its length in inches on a picture, if it is drawn with a scale factor of 1 inch to 30 feet?

Answer: ☐ inches

13.

Set up a proportion using the following numbers: 45, 6, 9, 30.

Answer: $\frac{\square}{\square} = \frac{\square}{\square}$

14.

In order to cover 12 sq. m of floor, 6 boxes of tiles were used. How many boxes of tiles would it take to cover 32 sq. m?

Answer: ☐ boxes

15.

Convert 48 inches per second into feet per minute.

Answer: ☐ feet/minute

GO ON

16.

Write the ratio of 0.35 to 0.28 as a fraction and reduce it to simplest form.

Answer: $\frac{\square}{\square}$

17.

Find and write two two-digit whole numbers whose ratio is 5.

Answer:

The first number is: ☐

The second number is: ☐

18.

Find the scale of a map if a segment of 6 cm on the map corresponds to a real distance of 90 km. Write your answer in the form of a ratio 1 : X, showing how many centimeters in reality correspond to 1 cm on the map.

Answer: The scale of the map is 1 : ☐

19.

Solve the equation: $\frac{2.7}{x} = \frac{2.4}{3.2}$

Answer: x = ☐

GO ON

20.

What is the price of 3.4 m of electric wire if 1.4 m costs $7.42?

Answer: ☐

21.

Burning one kilogram of coal gives the same amount of heat as burning 2.2 kg of wood. How much wood do we have to burn to produce the same amount of heat we would get from burning 3,000 kg of coal?

Answer: ☐ kg

22.

A crew of construction workers is building a 2-meter high wall. It takes the crew 7 hours to build an 850-meter long wall. Which proportion can be used to find *t*, the time needed to build a 3,540-meter long wall of the same height?

A. $\frac{t}{7} = \frac{850}{3540}$ **B.** $\frac{7}{t} = \frac{850}{3540}$ **C.** $\frac{7}{3540} = \frac{850}{t}$ **D.** $\frac{7}{3540} = \frac{2}{t}$.

23.

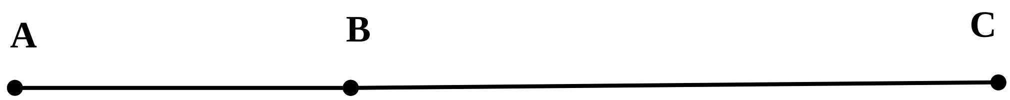
A presidential candidate was campaigning for one week, riding in a bus across the country. Every day, the bus was on the road for 5 hours. What was the bus's speed, if it traveled 2100 miles?

Answer: ☐ miles/hour

GO ON

24.

Find the length of segment AC if the length of segment AB is equal to 14 inches and the ratio of the length of AB to the length of BC is equal to 0.7.



Answer: ☐ inches

25.

Every fifth employee of Company A is a programmer, and every third employee of Company C is a programmer. In the beginning of the year each programmer got some pens. Find the ratio of number of pens distributed to programmers in Company A to the number of pens distributed in Company C. Give your answer as a common fraction in simplest form.

Employees of Companies A, B, and C

	Company A	Company B	Company C
Employees	35,000 ppl.	23,000 ppl.	18,000 ppl.

Number of the Pens Given to Each Programmer

	Company A	Company B	Company C
Black pens	2	2	2
Green pens	0	1	1
Red pens	1	3	1
Blue pens	1	0	2

Answer: $\frac{\square}{\square}$

26.

From these ratios, select the one that shows the price of 1 unit of merchandise. Then, imagine that the merchandise drops in price. Find the new price of one unit if, for the same cost as in the ratio you selected from below, you can now buy one more unit.

I. $\frac{\text{21 mm}}{\text{6 units}}$

II. $\frac{\$67}{\text{2 miles}}$

III. $\frac{\$56}{\text{7 units}}$

IV. $\frac{\text{6 units}}{\$42}$

Answer: ☐ per unit

27.

You have 2 similar rectangles. The perimeter of the first one is 48 cm, and the perimeter of the second one is 216 cm. Find the lengths of the sides of the rectangles if the width of the first rectangle is 10 cm.

Answer:

The length of the first rectangle is ☐ cm.

The length of the second rectangle is ☐ cm.

GO ON

28.

Two parking lots are rectangles in shape. These rectangles are similar. The area of the first parking lot is 24 sq. yards. Find the area of the second parking lot if the ratio of its length to the first lot's length is 3.

Answer: ☐ sq. yards.

29.

Solve the equation: $\frac{2z+4}{15} = \frac{7}{5}$

Answer: z = ☐

30.

On a map, the distance between two sea ports is 25 cm. The scale of the map is 1:3,000,000. A ship sailed from the first port to the other in two days. On the first day, it sailed 400 kilometers. What distance did the ship sail on the second day? Give the answer in kilometers.

Answer: ☐ km.

GO ON

31.

6 workers can dig a hole in 25 hours. How many more workers would you need to dig the same hole in 15 hours?

Answer: ☐ more workers.

32.

Find the values of three numbers if the ratio of the first number to the second number to the third number is 8:5:16. You also know that their mean is 29.

Answer:

The first number is ☐

The second number is ☐

The third number is ☐

STOP

Appendix B

Comments from Pretest and Posttest Reviewers

Comments from Dr. Michael L. Connell, Associate Professor, Mathematics Education, Department of Curriculum and Instruction, College of Education, University of Houston, Houston, Texas.

Let me begin by thanking you for the opportunity to examine these two instruments. I quite enjoyed examining them and was favorably impressed on the whole. I will respond to your prompts in the order they were presented.

1. Content validity as per TAKS. In my opinion, the items presented covered the main TAKS specification quite well. They did seem a bit "top heavy" in terms of item sophistication, however. To my mind, this is a benefit for evaluation purposes as it allows for growth to be better shown between the pre and post but I needed to mention it. The authors are to be commended for creating an instrument that had both content and face validity; the instruments appeared both thorough and professional.

2. The instruments exhibited parallel construction to an admirable degree. (Even to the extent that parallel errors were made in item wording; for example, item 25 in both the pre and post measures make use of the word "some." This is not precise enough to address the problem. One would need to specify that each child in each city or each programmer for each company—depending upon the instrument—would receive the same quantity of either balloons or pencil.) It is rare for this level of care to be shown in an individually constructed test and the authors are to be commended. The levels of the problems seemed to also be parallel with similarly worded problems being used to assess the same items from form to form.

3. The tests strike me, as was mentioned earlier, as being of a "ceiling" variety and seemed to include more sophisticated items then one might expect. However, with the increasing reading difficulty currently put into the TAKS, this may not be as big an issue as it first seems.

I did have a little concern about the lack of a standard response format. I recognize that this is a minor issue, but with the emphasis upon passing the TAKS, it might not hurt to have an answer response format that is parallel to that of the state test. It really cannot hurt and it might help down the road.

I hope that this helps.

Comments from Dr. Jan Moore, Secondary Mathematics Coordinator,
Curriculum Department, Fort Bend Independent School District,
Sugar Land, Texas

The task was to determine if the content validity of the RM2003 Pretest and RM2003 Posttest could be established to be at the seventh grade level. This was confirmed to be the case after I worked each problem and compared it to the Texas Essential Knowledge and Skills for Seventh Grade Mathematics.

The focus of a seventh grade mathematics program should include, and be centered around, the following: (1) using proportional relationships in number, geometry, measurement, and probability; (2) applying addition, subtraction, multiplication, and division of decimals, fractions, and integers; and (3) using statistical measures to describe data. There should be daily multiple step problem-solving activities integrated within appropriate content. The classroom environment should be one in which students are presented with opportunities to reason mathematically; make connections to other mathematical ideas and to other contents; create and use representations to organize and communicate mathematical ideas; and to use the language of mathematics to communicate their mathematical thinking both orally and in writing to peers, teachers, and others.

The content of both the pretest and posttest is quite rigorous with respect to the level of what they ask students to do. Many of the questions are at the application or higher level of Bloom's Taxonomy. There is a lot of problem solving. There is a great deal of content integration within each question. It is this integration that serves to increase the rigor of many of the questions.

Comments from Dr. Susan E. Williams, Associate Professor, Mathematics Education, Department of Curriculum and Instruction, College of Education, University of Houston, Houston, Texas

I have carefully reviewed the copies of the pretest and posttest that you sent me. I have included several suggestions on the pretest for the writer to consider. Overall, I was very impresses with the test items; they were well-written and test a variety of proportional reasoning concepts. Below, please find feedback to the questions that you posed:

1. I found the content of the test items to be valid for seventh grade mathematics. I did noted (on the pretest) several problems that have multiple possible correct answers. Changes will have to be made if the writer of the tests was intending to create items that had a single possible correct answer.
2. I believe the pretest and posttest are parallel in construction with the exception of items 23 and 32. I found item 32 on the posttest much easier to solve than item 32 on the pretest. Also, I found the answer to item 23 on the pretest to be unrealistic (given the setting of the problem) whereas the answer to item 23 on the posttest was reasonable.
3. The range of difficulty of the problems is quite varied. The problems range from application of a single basic proportional reasoning idea to multi-step problems which require the application of more than one concept. Several of the later items are quite challenging and involve problem solving. Most seventh graders will not be able to successfully complete those last items.

Appendix C

Student Questionnaire

Reasoning Mind, Inc.
2003 Pilot Project
Student Questionnaire

1. Did you like learning math on the RM system?

A. I liked it a whole lot

B. I liked it

C. It was O.K.

D. I didn't like it at all

2. In the future, where would you like to learn math most?

A. On the RM website

B. In my regular math class

C. It doesn't matter

3. Which class was harder this semester?

A. The RM class was much harder than the regular class

B. The RM class was harder than the regular class

C. They were about the same

D. My regular math class was harder than RM

E. My regular math class was much harder than RM

4. Where have you learned more math this semester?

A. I learned much more in RM than in my regular class

B. I learned more in RM than in my regular class

C. I learned about the same

D. I learned more in my regular class than in RM

E. I learned much more in my regular class than in RM

5. What did you like <u>most</u> about learning math on the RM website?

What else did you like about RM?

6. What did you like <u>least</u> about learning math on the RM website?

What else did you dislike about RM?

7. How much time did you spend with the RM system outside of class? (You don't have to answer with a number.)

Do you have access to a computer outside of school that works with RM?

8. How did your liking of math change after the RM class?

A. Now, I like math <u>a whole lot</u> more than before

B. Now, I like math more than before

C. I like math the same as before

D. Now, I like math less than before

E. Now, I like math <u>a whole lot</u> less than before

9. Which of the following activities on the RM website did you find useful or interesting? <u>Check all that apply.</u>

	Useful/Interesting	Not Useful / Not Interesting
Guided Study	☐	☐
Independent Study	☐	☐
Classrooms	☐	☐
Problem Solving Games	☐	☐
Dino Island Game	☐	☐
E-mails to and from the Genie	☐	☐

10. Is there anything else you'd like to say about RM?

Appendix D

Teacher Questionnaire

Reasoning Mind, Inc.
2003 Pilot Project
Teacher Questionnaire

1. In your opinion, were the students engaged and interested in the RM class? Please explain.

2. Do you think RM is good for the students? Do you believe it could be a useful tool for teachers like you?

3. Is there anything else you'd like to say about RM?