AN OBSERVATIONAL STUDY OF STUDENT TEST PERFORMANCE AND MATHEMATICAL COMPREHENSION AT THE MARION SHADD WORKFORCE DEVELOPMENT SITE

By Chris Armstrong and Matthew Hiesiger

ABSTRACT. Mathematics education is a significant aspect of workforce development, particularly in the construction trades. This study attempts to evaluate the effectiveness of several different types of program entrance assessments that are currently in use in the field of workforce development: the CASAS, CASAS Level-Set, and the TABE. Also, this study attempts to discover the areas in which students have the most difficulty with respect to the math sections of each of these assessments. Suggested improvements are given regarding the instructional subjects that would be most effective in furthering workforce development. Site-specific analysis on student learning and attendance trends is also given for the Marion Shadd Workforce Development site.

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REPORT SUMMARY

KEY FINDINGS

Our observation was carried out over a period of about 14 weeks during the Spring and Summer semesters. The study was based in the Math Lab, a mathematics resource center for students entering and in the Workforce Development Programs at Marion Shadd. Overall, our study found that students within the workforce development programs at Marion Shadd had weak mathematical abilities. The consequences of this fact are of no small importance as the men and women being educated in these programs are likely to matriculate to professional apprenticeship programs and/or professional worksites. Having a well-developed mathematical assistance program would help to develop workplace skills for our students to not only thrive in these environments safely, but to also work for themselves if they take the time to develop their business acumen in addition to their mathematical abilities.

CASAS, CASAS Level-Set, and TABE Assessments

A major hindrance to students wishing to enter the programs is the CASAS entrance assessment.

Although the data are incomplete for the attrition rate associated with students failing the CASAS on their first attempt, an initial estimate put this number at around 50%. This means that for every 2 students that walk in the door, 1 stays. A key purpose of this report was to address why this was occurring and how to remedy it. **Our major findings also suggest that as it is currently being used, the CASAS has too low of a passing score, is too slanted towards certain types of math, and needs to be re-structured in order to abate the likelihood of passing from guessing.**

The CASAS Level-Set is also problematic in that the method of testing students' mathematical abilities is not focused enough on computationally-driven questions. Indeed, the bulk of the questions on the CASAS Level-Set are based on critical reasoning skills, which, in the absence of a good foundation of computational abilities, will be very difficult for our students. That is to say, students must learn how to carry out basic mathematical computations before they can be expected to reason their way through more complicated math problems.

Another purpose of this report was to determine if a secondary assessment, the TABE, would be a better fit for assessing students' mathematical abilities, and also the role that it could play in providing ongoing mathematical assistance for students in the programs. The TABE comes in a pre- and post-form to be given before and after mathematical assistance, respectively. In this way, it serves as a more effective gauge of students' mathematical abilities and how these may have changed over the course of receiving such assistance.

In general, all of the students who both took the pre- and post-TABEs and received mathematical assistance from the math lab increased their scores, and in some cases improved

them exceptionally. This suggests that investing in mathematical resources for students would improve both student retention and overall program success.

Program Attendance and Student Characteristics

In addition to our analysis of the CASAS and TABE assessments, we kept track of student attendance in the Math Lab. We also kept track of the topics that students worked on with us. The central question we were asking was "when do students want to come, how long do they want to stay, and what do they need to learn?" Answering these questions allowed us to address the questions of retention rate and curricular effectiveness. **Our findings suggest that there are many different student learning profiles, and that these must be addressed in any design of a mathematics assistance program.**

Our first and arguably most important data point was the number of sessions each student attended. **In keeping track of student attendance, we classified students into "Consistent Students" and "Inconsistent Students". Consistent Students were those that attended 5 or more sessions in the math lab, Inconsistent Students were those that attended 1 to 4 sessions. Our goal was to develop a program that had both a consistent student base and curriculum that was directly applicable to our students' respective trades.** These goals were met with moderate success, and **about a third of our students were repeat customers and the other two-thirds were inconsistent (non-repetitive) in their attendance.**

The Most Studied Topics

We were interested in seeing what topics students needed the most help with, as this information directly guided curriculum development. Somewhat in line with our expectations, in general, **students needed the most help with CASAS Prep, and Fractions, Decimals, and Percentages.**

For our Consistent Students, by far the most studied topic was that of Fractions, Decimals, and Percentages, followed by Other topics, such as trade-specific mathematics. For our Inconsistent Students, the most studied topic was CASAS Prep, followed by Fractions, Decimals, and Percentages.

Attendance Characteristics

To aid in developing our program, we were also interested in keeping track of both how long and on what days students were coming to the Help Room.

During the observation period, about 40% of Consistent Students came for 12 or more total hours, with another 20% coming for between 3 and 4 total hours, 13% coming for between 4 and 5 total hours, and 13% coming for between 7 and 8 total hours.

As for the Inconsistent Students, there were three major clusters. The largest cluster was students coming for 3 or more or total hours (29%), followed by 2 total hours (22%), and then 1 total hour (18%). Similarly to the data on Number of Sessions, these statistics indicate that Inconsistent Students may have come for a session or two and spent a total of 1 or 2 hours and then moved on; this was often the case with students coming solely for CASAS Prep. However, some students also spent a considerable amount of time concentrated in 1 or 2 sessions on CASAS Prep. This statistic is supported by the discussion in Part II of this report.

In general, **the findings indicate that the best days for Consistent Students were Monday, Tuesday, and Wednesday (in that order). The findings also indicate that the best days for Inconsistent Students were Monday, Thursday, and Wednesday (in that order).**

As for the best time of day for Consistent Students, **the findings indicate that Consistent Students preferred to come to the Help Room between 3 and 5 P.M. This time period is immediately before the start time for most of the courses at Shadd, 5 P.M. Inconsistent Students showed much more variability in their time preferences, with as many as 5 distinct time clusters (see Part II of this report).**

Predominant Mode of Learning

As part of our observational study, we were also interested in how often particular modes of learning were encountered. In general, we did not mandate certain modes of learning for our students, the Workshops notwithstanding; we were curious to see how students reacted when learning on their own versus learning with another person, in a small group, or in a lecture/workshop setting (detailed in Part II of this report). It was our belief that the mode of learning would affect both student confidence with and comprehension of lessons contents. **For our Consistent Students, there was a nearly-even split in the Predominant Mode of Learning between the One-on-One and the Workshop modes. For our Inconsistent Students, One-on-One was again a dominant mode, with the next most commonly experienced mode of the Small Group. A decent minority also experienced the Learning Partner mode.**

RECOMMENDATIONS

Assessments

In light of both the structure and content difficulty associated with the CASAS, and the objectivity and "before and after" model inherent in the TABE, **it is our primary recommendation that the CASAS be replaced with the TABE as the entrance assessment for the workforce development programs.**

Compared to the CASAS, which requires students to use multiple mathematical skills simultaneously, **we believe that the TABE is a better assessment test to be used as an entrance exam.** Alternatively, the TABE could be used in concert with the CASAS. Upon examination of the questions on the Computations and Applied Math sections of the TABE, **it is evident that the**

TABE is better at assessing mathematical skills in each particular area and in more direct workplace contexts than the CASAS.

Additionally, the TABE offers a more equitable balance between each subject. Hence, we would recommend that the CASAS be rewritten to resemble this style of test. Furthermore, our recommendation is that future instructional curriculum should focus on the lowest scoring areas of the Computations Section of the TABE as indicated by incoming students. Part I of this report details the success with which 9 of our students were taught over a 4-week period using this approach.

Pre-CASAS Testing

In the event that the CASAS is retained as the primary entrance exam, **it is our recommendation that a pre-CASAS assessment be given to any student wishing to enter the Workforce Development programs. This quiz would consist of 5 problems testing the most problematic content as identified by the analysis in Part I of this report. Students not passing this quiz would be mandated to attend a mathematics assistance course before taking the full-length CASAS.**

We realize that this presents another obstacle for students already unsure of their abilities; however, for both the health of the program and the assurance of student success going forward, it is likely that students would benefit by receiving help before undertaking the full-length CASAS.

Key Skills Workshops and Mandated Mathematical Assistance

In addition to the pre-CASAS, it is our recommendation that Key Skills workshops be implemented for the purpose of providing ongoing mathematical assistance to our students. The material covered in these workshops would consist primarily of fundamental mathematical concepts, such as decimals, fractions, percentages, negative number operations, geometry, and basic algebra.

In light of the results presented in Part I, **it is also our recommendation that students scoring below a 231 on the CASAS on their first attempt be mandated to receive mathematical assistance for at least a few weeks at the outset of their coursework.** This would help to develop a solid mathematical foundation that would ensure student success in our programs.

A further study on the effect of learning mode is also recommended.

Retrieval of Mathematics Data from Instructors

Instructors are the primary point-of-contact for students once the students have passed the CASAS. As such, **the instructors are in the best position to both implement and retrieve mathematical exercises and performance data from the students.**

A number of different metrics could be established by retrieving mathematically-based exercises and exams from the instructors. Coupling these data with the TABE categories would allow students' ongoing mathematical performance to be measured. Similarly, using terminal grades for students' respective courses would allow for a corollary study to be carried out involving variables such as pre/post-TABE scores, instruction effectiveness, mean test score, etc…

eCASAS

Although the specifics of the paper and electronic versions of the CASAS do not differ materially, the quickness, ease, and reliability of the electronic version suggest that the electronic version is the way to go. **The primary benefit of the eCASAS is the ability to gather large sets of data in a short amount of time. The writing of this report required manually inputting over 200 scores, with a number of answer sheets being marked incorrectly. Thus, to improve reliability of student scores and to enhance ongoing monitoring, it is highly recommended that the eCASAS be implemented.**

Mandatory TABE Testing for Courses

Although the CASAS provides a baseline assessment of student mathematical competencies, we believe that the TABE is a more accurate reflection of students' mathematical abilities. The TABE was required for all students wishing to receive mathematical assistance from the lab for reasons previously noted and it is our belief that the TABE should be used in conjunction with the CASAS, if not outright replacing it. **If the CASAS remains as the primary entry assessment, the TABE should be required for students at both the beginning and end of classes.**

CONCLUSIONS

Our students at Shadd represent much potential for the continued success of the workforce development program. As was demonstrated by 9 of our most dedicated students, given the right resources, the potential to flourish is great.

With some adjustments to the entrance procedures and the implementation of an ongoing mathematics program, Shadd would be poised to represent a success story for not only the UDC Community College, but for the talent latent in wider Southeast Washington.

PART I

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SECTION I

DESCRIPTIONS OF ANALYSES

Introduction

The goal of this study was to identify student competencies in the various areas of applied and occupational mathematics and to assess the efficacy of the tests that are administered at the Marion Shadd Workforce Development Center. Three varieties of math tests are administered at the Marion Shadd Workforce Development Center: the CASAS, the CASAS Level-Set, and the TABE.

The CASAS[1] is administered to all Workforce Development students upon expressing interest in the program. It is a two section test. The first section is a twenty-five question[2] assessment of reading skills. The second section is a twenty-five question[3] assessment of mathematical ability. No student can register for a Workforce Development class without receiving a passing score on both the reading and math sections of the CASAS.

If a student fails either section of the CASAS, they may take a CASAS Level-Set[4] for the section which he or she did not pass. No student may retake the regular CASAS within one year of failing it.

The TABE is administered when a student wants a better assessment of their math abilities. It is split into pre- and post-TABEs in order to objectively assess a student's mathematical abilities. Students generally avoid taking the TABE, because it does not count towards anything and it is fairly time consuming to take. All students who took the TABE[5] took the Computational Math and the Applied Math sections. In our data we also had nine students who took just the pre- and post-TABE Computation[6] sections after spending time with us in the classroom learning math. The questions in both of the Computations Sections of the TABE contain five answer choices, alternating between A through E and F through K. The questions on Applied Mathematics Section contain four answer choices, alternating between A through D and F through J.

Method

All Tests

We first constructed a simple algorithm which allowed us to calculate average scores for each individual question and determine total scores for each individual student. Hence, we were

[1] Form 130 Level B
[2] Four answer choices per question
[3] Also four answer choices per question
[4] Form 13 Level B
[5] Form 9 Level D
[6] Form 10 Level D

able to determine the relative difficulty of each question. We also found it useful to record each individual answer choice for each question. We accomplished this by using the standard binary integers of zero and one. In this way we were able to determine the number of test-takers that chose each particular answer choice. We were then able to scrutinize the most commonly chosen wrong answers.

CASAS

While analyzing the data from the CASAS tests we made the following assumptions:

- The probability of an answer choice being randomly chosen was normally distributed.
- This normal distribution had a mean and standard deviation based on a binomial random variable with $p = \frac{1}{3}$ being the probability that a student randomly chose a particular wrong answer, given that the student answered the question incorrectly.
- The correct answer was not factored into this calculation because we assumed that there would be a valid reason, circumventing randomness, for choosing the correct answer.

Hence, in order to determine whether an incorrect answer was significantly more commonly chosen than the others, we compared it to a normal distribution. We used the standard z-score formula for calculating the probability of an incorrect answer choice being randomly chosen:

$$z = \frac{x - \mu}{\sigma}$$

With μ = np, where n is the number of students who answered the question incorrectly, and $\sigma = \sqrt{np(1-p)}$. We then referenced a z-score table to determine the probability of an incorrect answer choice being chosen x number of times or more. The criteria for an answer choice being labeled as significantly more commonly chosen than the other answer choices was that there was less than a 5% chance that such a high incidence was due to randomness. We also used this method to determine if an incorrect answer choice was chosen significantly fewer times than the other incorrect choices.

Using these methods we were able locate specific subject areas in which students had the most trouble. Also, we were able to use what we had determined were the most common mistakes that students made on each question to guide curriculum development in those subjects (detailed in Part II of this report).

On the CASAS we conducted one additional level of analysis. We used the answer choices, which we had determined to be chosen significantly least often, to create an algorithm that would measure the likelihood that an individual guessed on the majority of questions. For every question where a student chose the least chosen incorrect answer choice, the student got a point. The points are then added together, producing a score for each individual test-taker. This score essentially measured the relative probability that the test-taker guessed on questions, and his or her frequency of guessing. Note that each score does not correspond to a specific probability or frequency, but instead rates relative probabilities and frequencies. We acknowledge that that this algorithm is biased towards lower scoring test-takers. However, we merely wanted to know how prevalent this behavior was, assuming that the relative behavior of low scoring test-takers could be somewhat generalized to the entire population of test-takers. We called the score produced by this algorithm, the Relative Guess Score.

We conducted this analysis because the passing grade for the CASAS in the workforce development programs required that a minimum of twelve questions be answered correctly. A table is provided later in the discussion section which illustrates a problem with using this threshold for a twenty-five question test with only four answer choices per question.

CASAS Level-Set and TABE

Since our sample of test-takers was significantly smaller for the CASAS Level-Set and TABE tests relative to the CASAS, we established statistical significance solely using a binomial distribution. We used the following formula to determine if an incorrect answer choice was chosen significantly more often than the others:

$$\sum_{k=x}^{n} \binom{n}{k} p^k (1-p)^{n-k}$$

where $p = \frac{1}{a-1}$ and a is the number of answer choices for a question, n is the number of test-takers who answered a given question, and x is the number of test-takers who chose a particular incorrect answer choice.

We reported statistical significance only if our calculations, using the above formula, resulted in a less than 5% probability that the observations were caused by randomness.

TABE

We chose to conduct one extra level of analysis for the TABE. Since on the TABE students were instructed to only answer questions that they were confident that they could answer correctly, we were able to measure each student's ability to assess their own knowledge. We designated this parameter the Rumsfeld Assessment Score. The Rumsfeld Assessment Score is measured on a standard percentage scale, and is calculated by dividing the number of correctly answered questions by the number of attempted questions.

SECTION II

RESULTS

Tests

CASAS

246 CASAS tests were administered. 136 students passed and 110 students failed. The mean score was observed to be 12.1 correct questions out of a possible 25. The standard deviation was observed to be 5.1 correct questions. 43 of the 246 test-takers skipped at least one question. The following table reports the breakdown of each question:

Question Number	Correct Answer	Most Common Wrong Answer	Number Correctly Answered	Number of Times Skipped
26	A	B	191	0
27	B	A	145	4
28	C	B	167	0
29	A	D	112	4
30	A	C	89	7
31	C	B[7]	96	11
32	A	C[7], D[7]	148	6
33	B	C	183	3
34	D	C	191	6
35	B	C[7]	146	4
36	C	A	115	4
37	D	C[7]	115	6
38	B	D	164	5
39	C	A	129	9
40	A	B	107	7
41	B	A	120	8
42	C	D	113	9
43	A	C	88	9
44	A	B[8]	78	7
45	C	A[7]	82	8
46	D	A[9]	58[10]	10
47	C	D	131	11
48	B	A	139	13
49	A	B[9]	17[11]	12
50	D	C[9]	53[11]	10

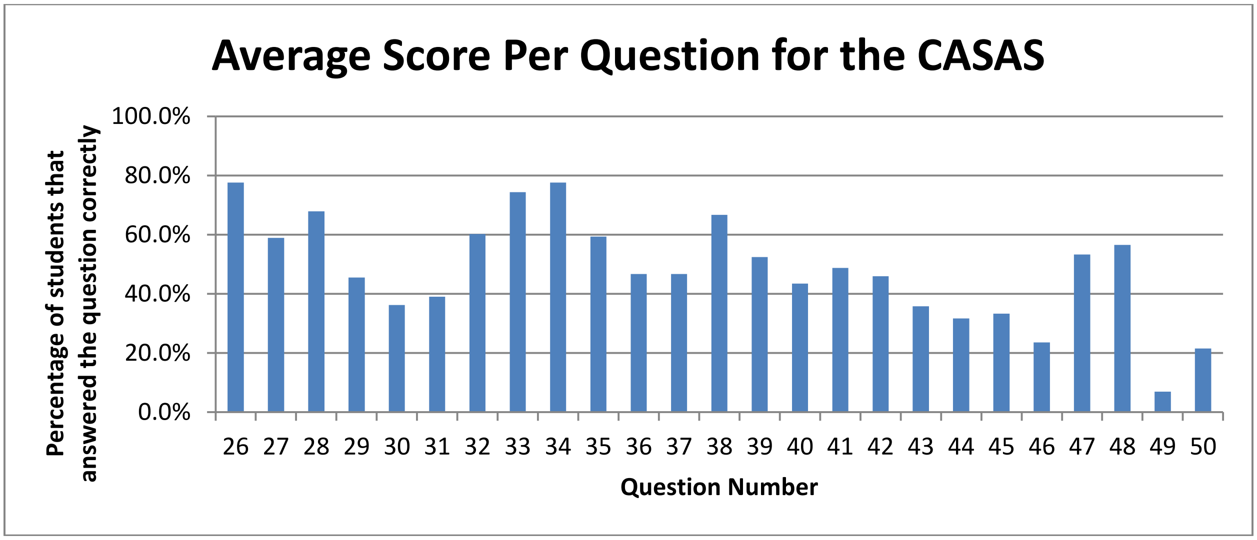
7: The incidence of choosing this incorrect answer is not significantly higher than the other incorrect answers.

8: The most commonly chosen incorrect answer was chosen equally as often as the correct answer.
9: The incidence of choosing this incorrect answer was higher than the incidence of choosing the correct answer.
10: This is well within the range of expected number of correctly answered questions due to complete randomness.
11: This is significantly lower than the expected number of correctly answered questions due to complete randomness.

Table 1 – Breakdown of each question on the CASAS.

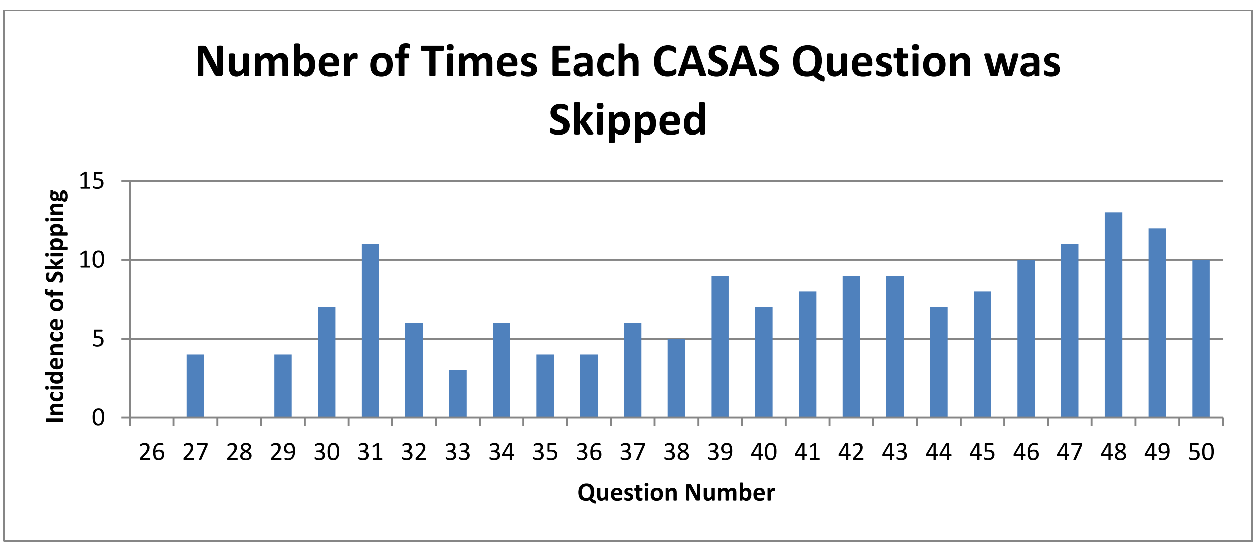
The following is the distribution of the average score for each question:

Figure 1



Also, the following is a distribution of the number of times each question was skipped:

Figure 2



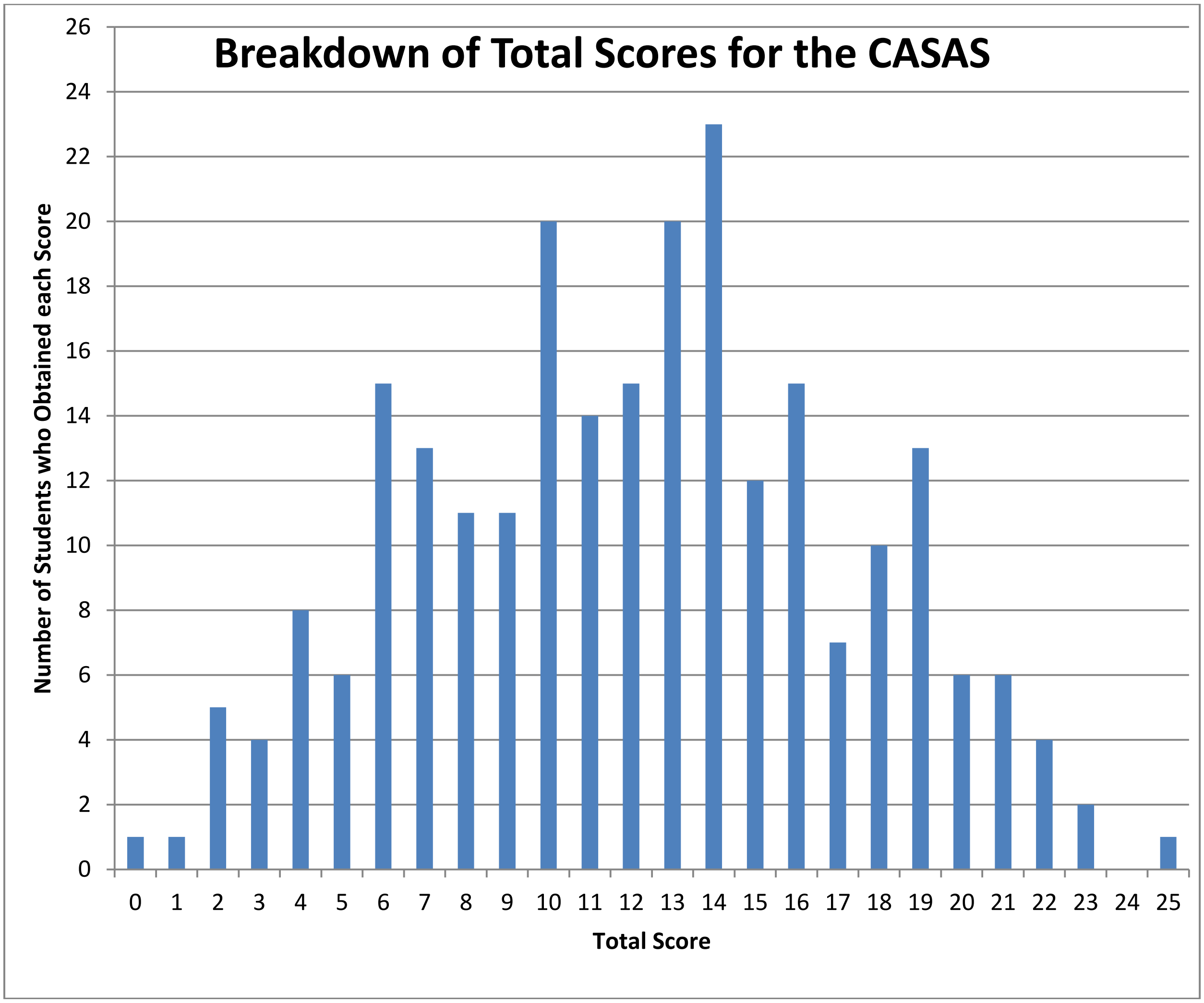
The following is a table of the Relative Guess Score breakdown:

Relative Guess Score	Number of Test-Takers That Received This Guess Score
7	2
6	6
5	7
4	23
3	40
2	44
1	82
0	42

Table 2 – Relative Guess Scores on the CASAS.

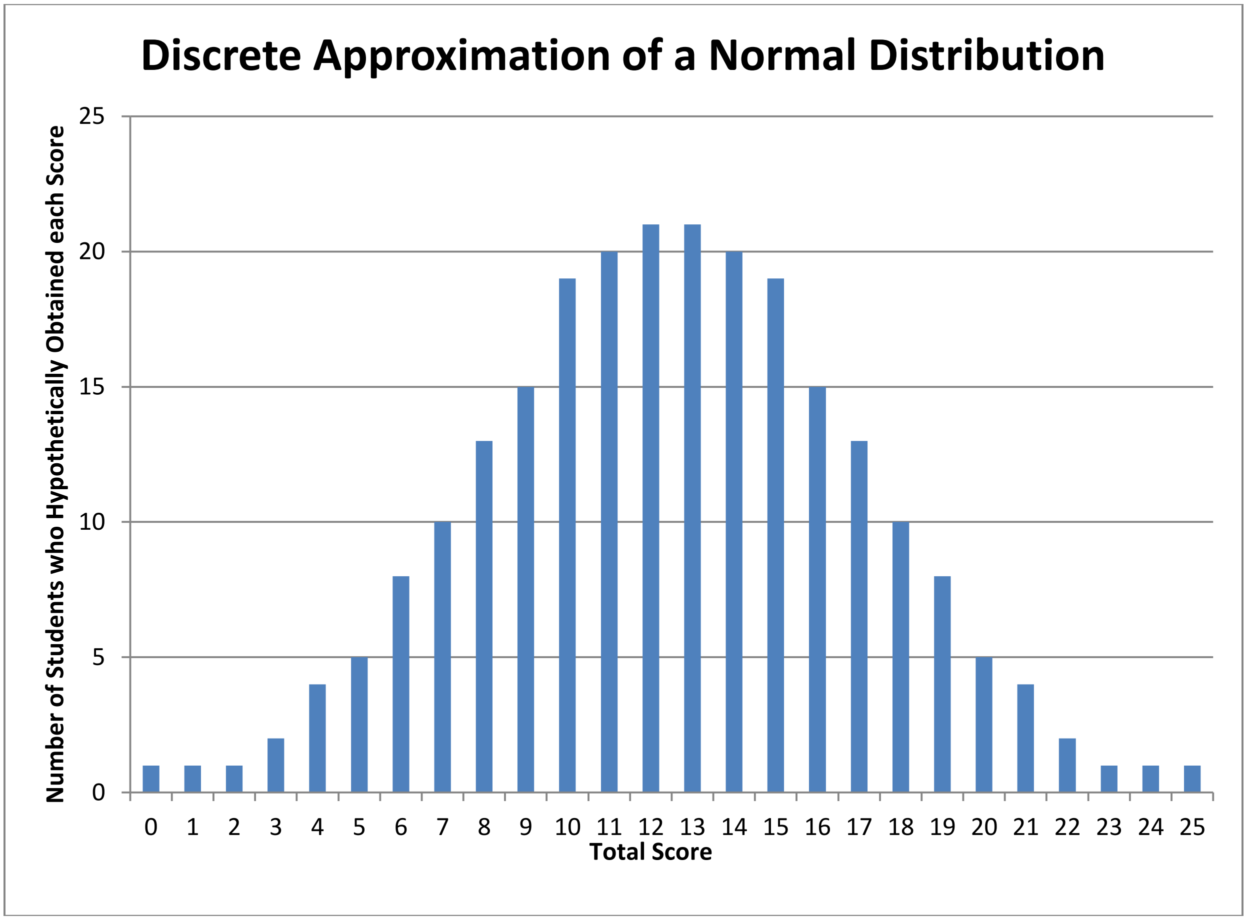
The following is a distribution of the total scores:

Figure 3



You can compare the above figure to this discrete approximation of a normal distribution with a mean of 12.5 and a standard deviation of 4.5:

Figure 4



CASAS Level-Set

33 CASAS Level-Set tests were administered. 9 students passed and 24 students failed. The mean score was observed to be 21.2 correct questions out of a possible 31. The standard deviation was observed to be 4.2 correct questions. Only 1 of the 33 test-takers skipped at least one question. The following table reports the breakdown of each question:

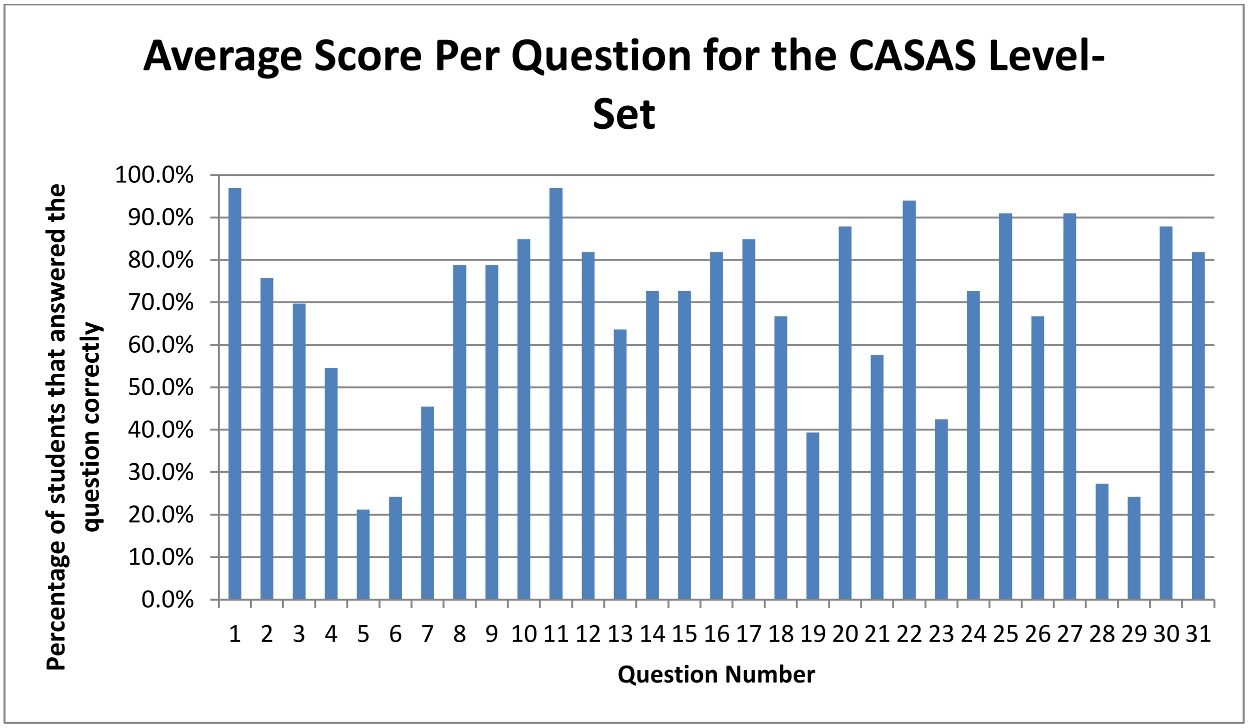
Question Number	Correct Answer	Most Common Wrong Answer	Number Correctly Answered	Number of Times Skipped
1	A	D	32	0
2	C	B[12]	25	0
3	B	D[12]	23	0
4	D	A	18	1
5	A	C[13]	7	0
6	D	B[13]	8	0
7	A	B[12], D[12]	15	0
8	B	C[12]	26	0
9	C	A[12]	26	0
10	B	A[12]	28	0
11	C	B	32	0
12	A	B	27	0
13	D	B	21	0
14	C	A[12], B[12]	24	0
15	B	D[12]	24	0
16	C	A[12], B[12], D[12]	27	0
17	C	B	28	0
18	A	B[12]	22	0
19	B	A[12]	13	0
20	B	A[12], C[12]	29	0
21	D	B[12]	19	0
22	D	C	31	0
23	A	C[12]	14	0
24	B	A[12]	24	0
25	C	A[12], B[12], D[12]	30	0
26	B	A[12], D[12]	22	0
27	D	B[12]	30	0
28	D	A[13]	9	0
29	C	B[13]	8	0
30	D	A[12], B[12]	29	0
31	D	B	27	0

12: The incidence of choosing this incorrect answer is not significantly higher than the other incorrect answers.
13: The incidence of choosing this incorrect answer was higher than the incidence of choosing the correct answer.

Table 3 – Breakdown of each question on the CASAS Level-Set.

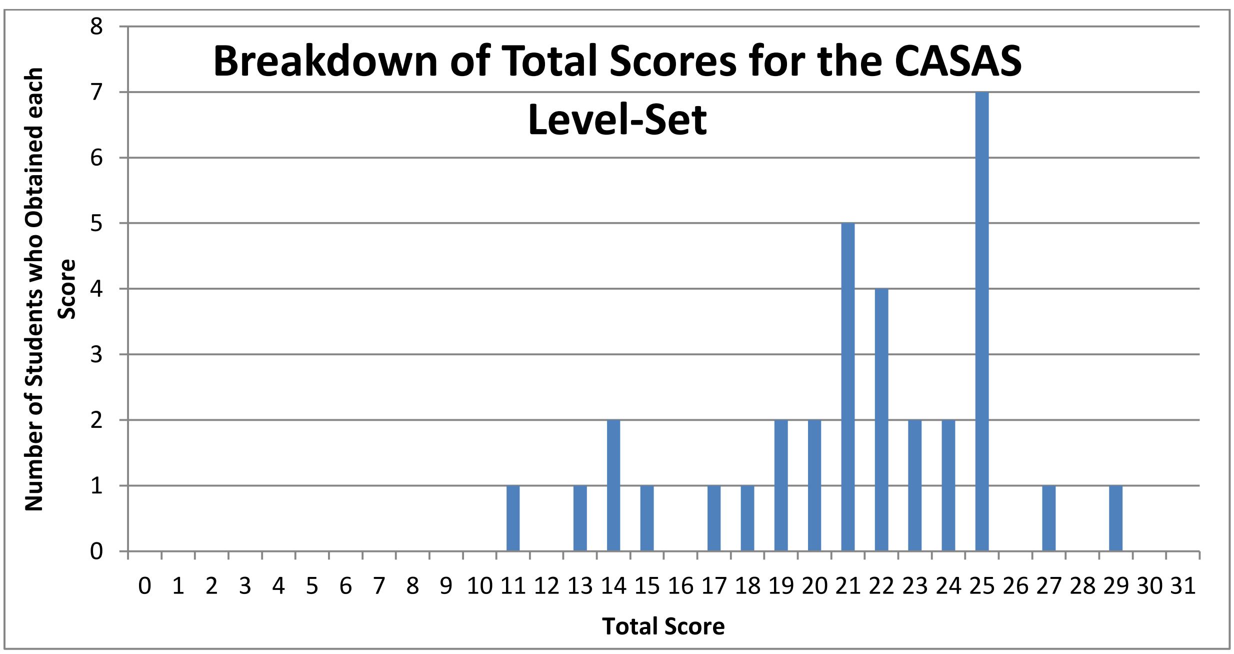
The following is the distribution of the average score for each question:

Figure 5



The following is a distribution of the total scores:

Figure 6



TABE – Computational Mathematics

37 TABE tests were administered. Since the test is merely an assessment, there were no pass/fail criteria. The mean score was observed to be 22.8 correct questions out of a possible 40. The standard deviation was observed to be 6.8 correct questions. 28 of the 37 test-takers skipped at least one question. The mean Rumsfeld Assessment Score was 68.215%. The following table will report the breakdown of each question:

Question Number	Correct Answer	Most Common Wrong Answer	Number Correctly Answered	Number of Times Skipped
1	A	N/A	37	0
2	G	J[14], K[14]	34	1
3	E	A[14]	31	1
4	H	G	24	1
5	D	A[14]	30	0
6	H	K	30	1
7	D	B[14], E[14]	31	0
8	J	K[14]	26	0
9	D	C[14], E[14]	34	1
10	F	H[14], J[14]	25	7
11	A	E	26	2
12	F	K	33	0
13	B	E	24	1
14	J	F[14], H[14], K[14]	28	0
15	A	E	27	3
16	G	F	18	2
17	C	B[14], E[14]	20	9
18	G	F	20	5
19	C	B	20	4
20	G	K[14]	23	6
21	C	B[14]	10	12
22	H	K	18	3
23	D	E	20	9
24	H	J[14]	9	19
25	B	D	14	9
26	F	J	17	6
27	A	C[14]	27	6
28	H	K	14	12
29	D	A[14]	27	3
30	F	K[14]	14	14
31	C	B[15]	10	10
32	G	H	22	5
33	B	D[14]	7	20
34	F	J[15]	5	21

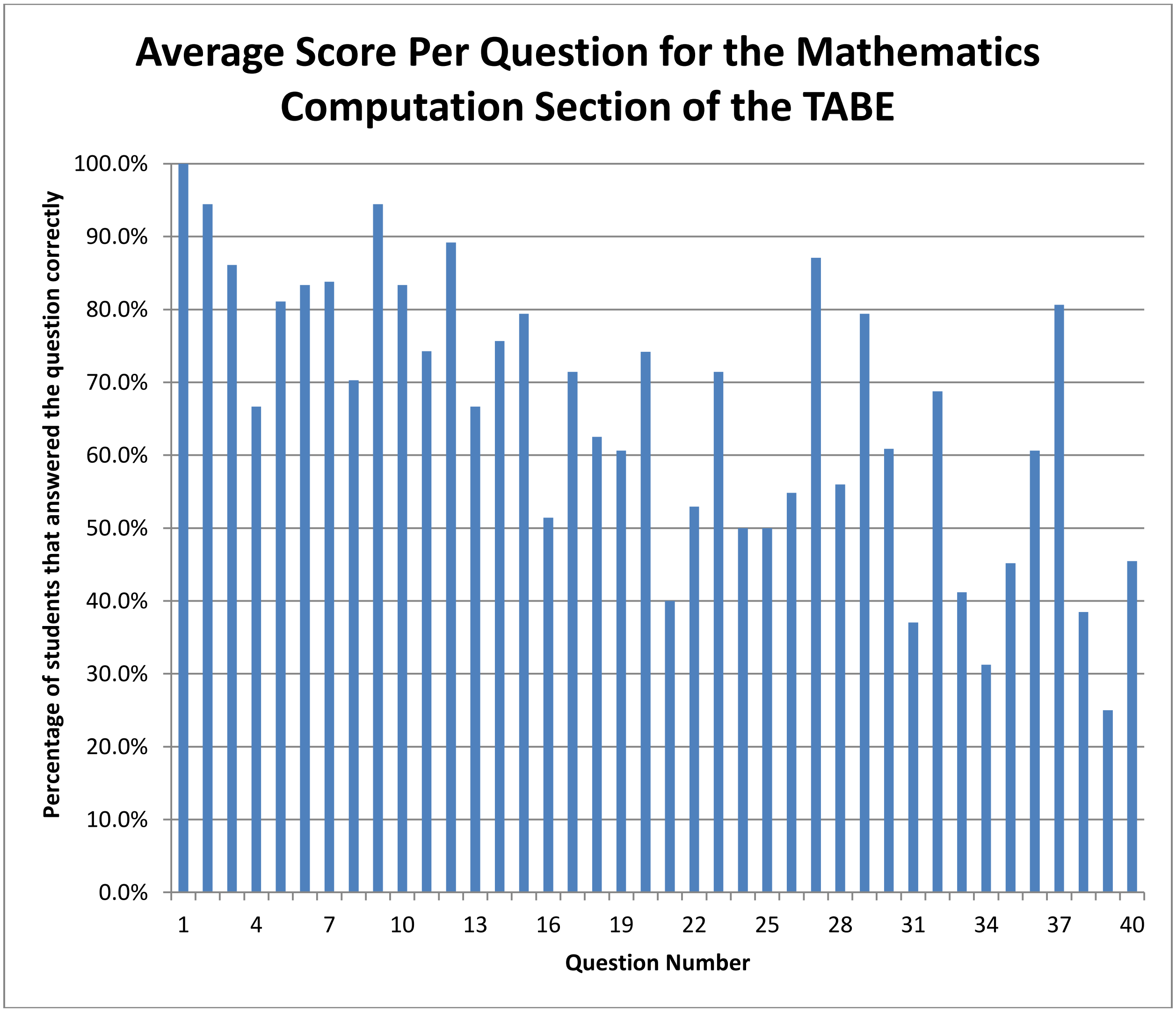
35	D	B	14	6
36	G	H	20	4
37	A	D[14]	25	6
38	H	F[14]	10	11
39	A	B[15]	8	5
40	F	K	10	15

14: The incidence of choosing this incorrect answer is not significantly higher than the other incorrect answers.
15: The incidence of choosing this incorrect answer was higher than the incidence of choosing the correct answer.

Table 4 – Breakdown of each question on the Mathematics Computation Section of the TABE.

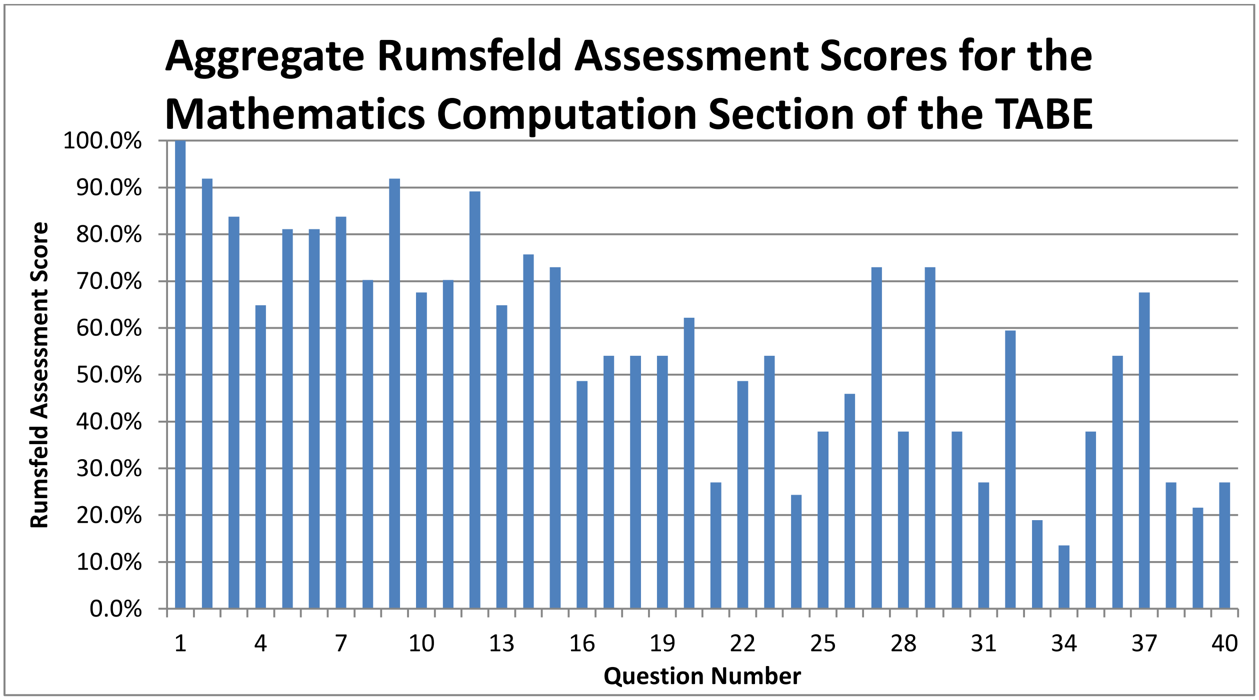
The following is a distribution of the average score for each question:

Figure 7



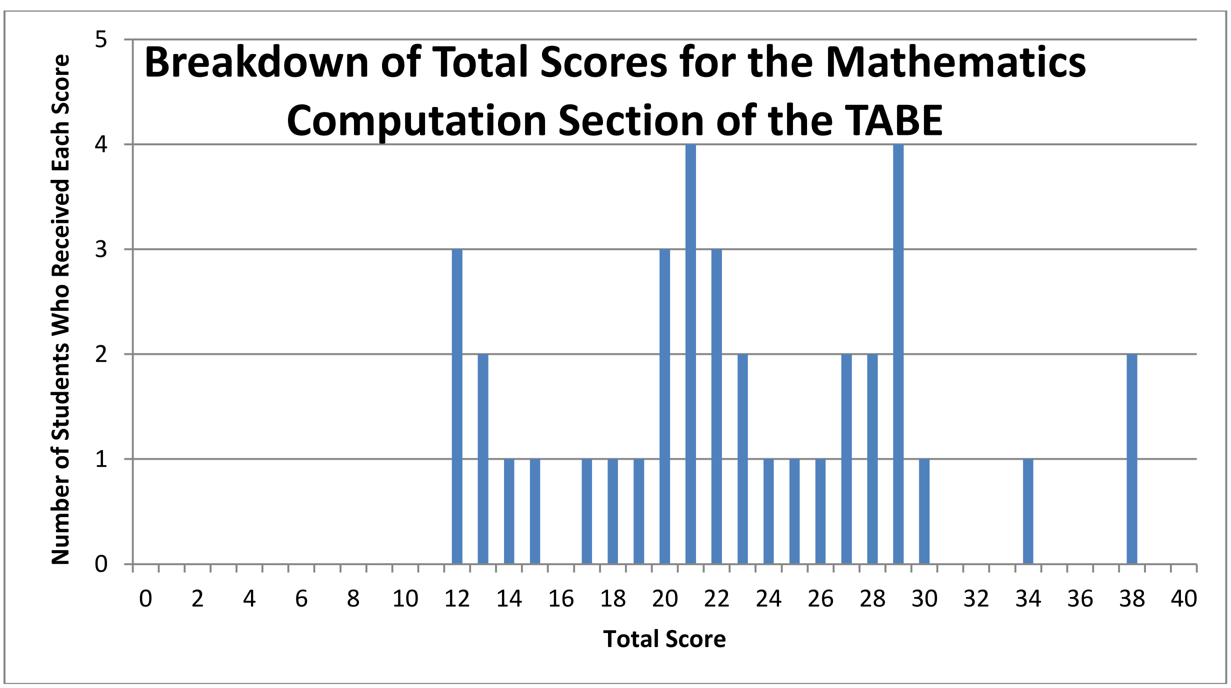
The following is a distribution of the aggregate Rumsfeld Assessment Score for each question:

Figure 8



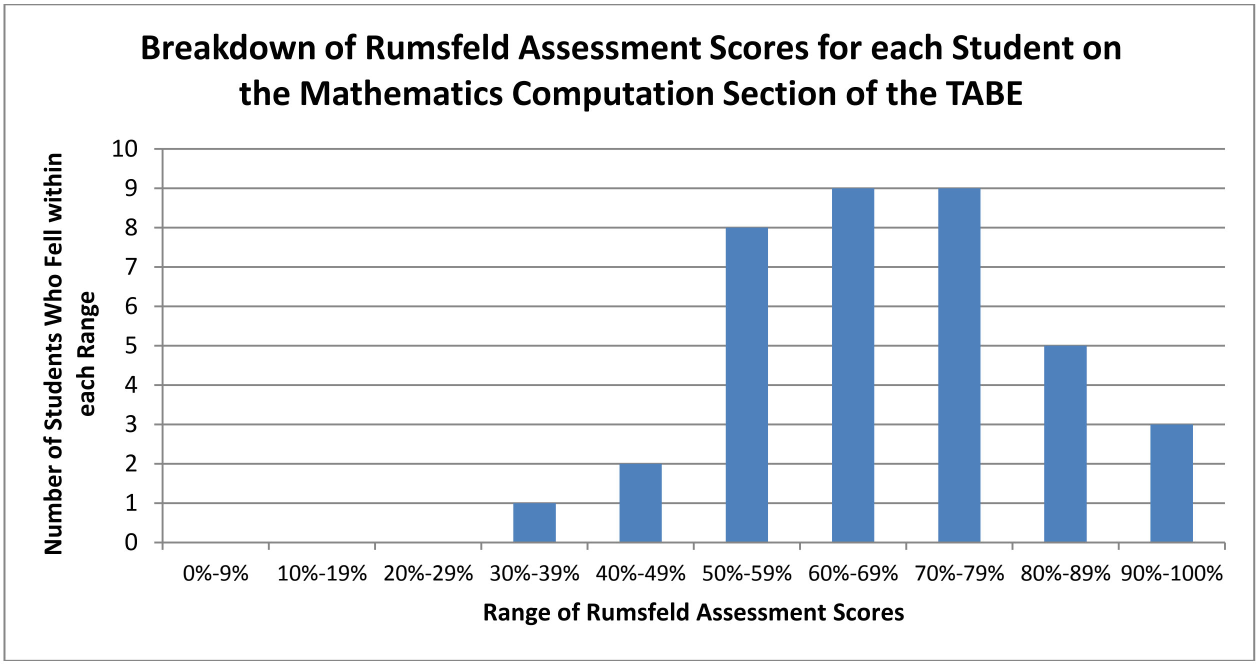
The following is a distribution of the total scores:

Figure 9



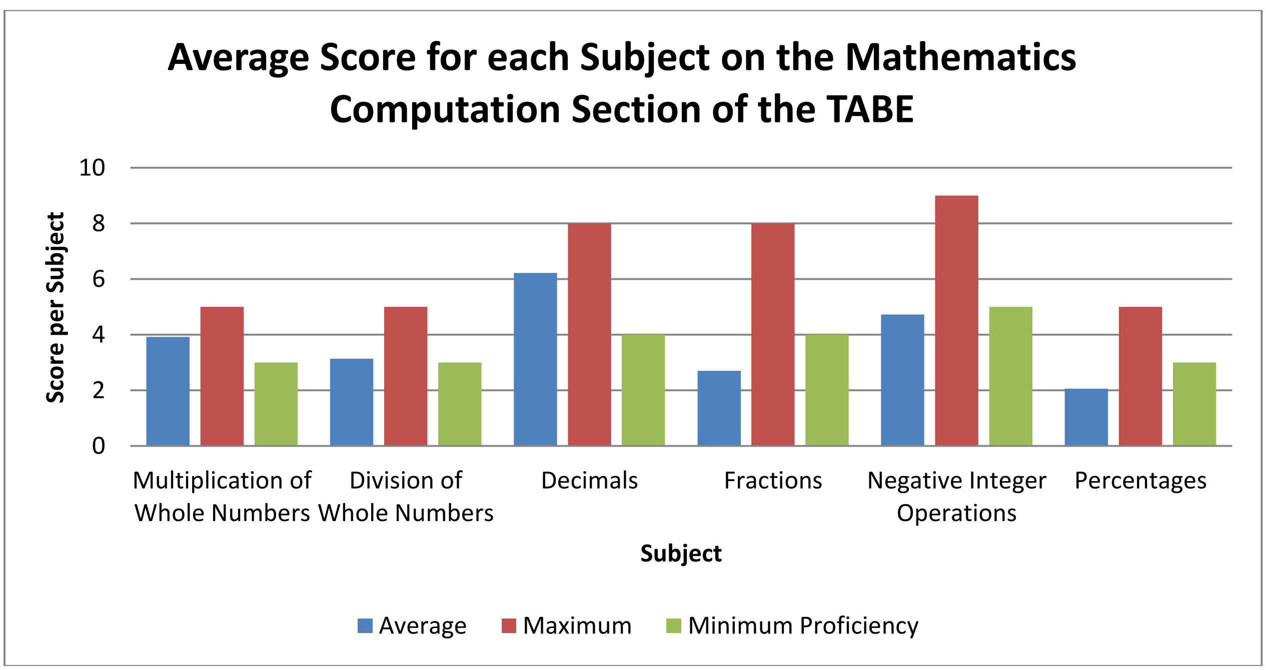
We can also look at the distribution of Rumsfeld Assessment Scores for each student:

Figure 10



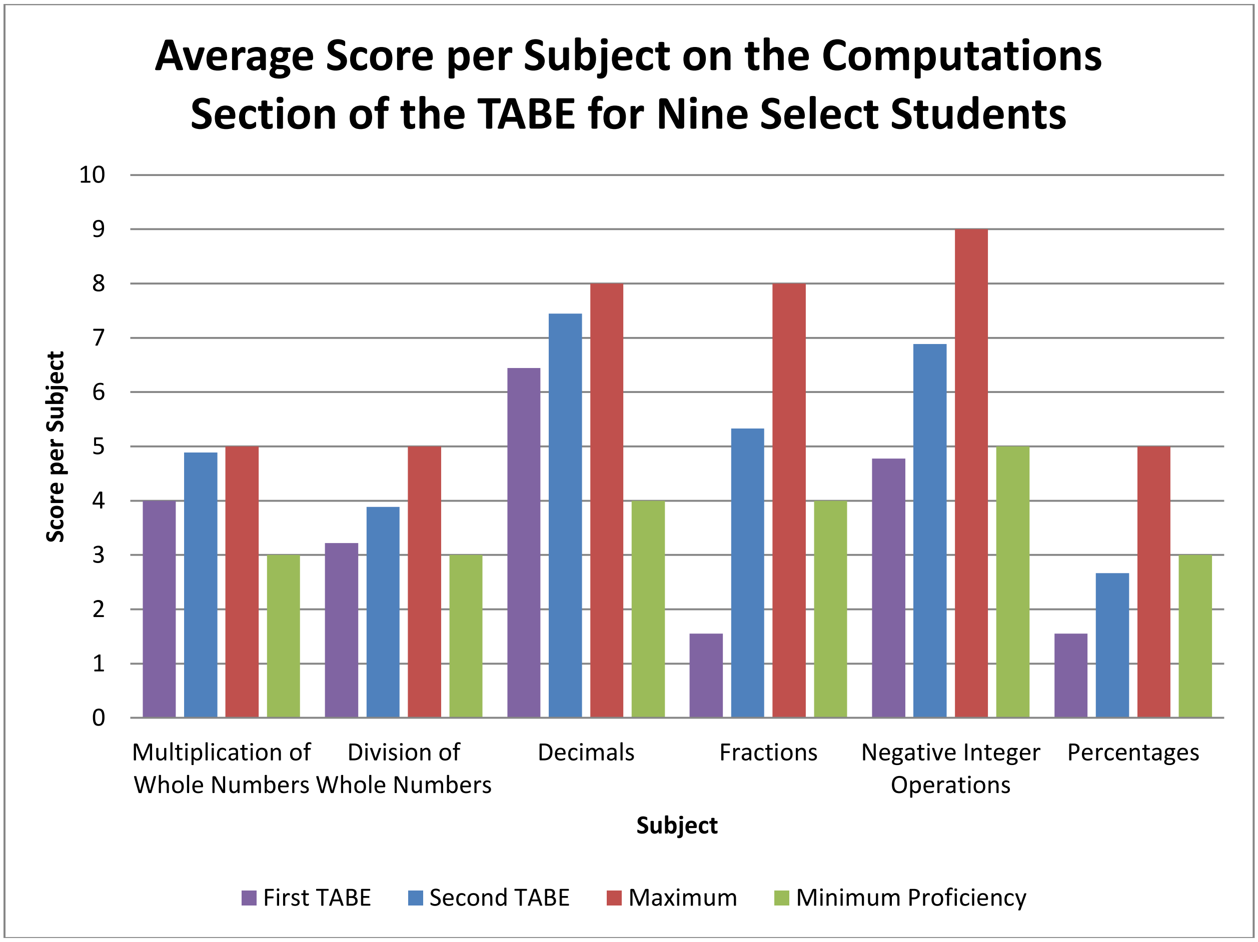
Additionally, the TABE has a subject-based breakdown of all of its questions. Here is a graph of the average score for each subject on the Mathematics Computation section of the TABE:

Figure 11



Furthermore, we had nine students who took the Mathematics Computation section of the TABE, spent four weeks in one of our mathematics classes, and then took the same section of another TABE exam.[16] The following is a graph of the average score per subject for those nine students, for their first TABE compared to their average score per subject for their second TABE:

Figure 12



Also consider the following statistics comparing these nine students' two TABE scores. The mean score for their first TABE was 21.6 correct questions; the mean score for the second TABE was 31.1 correct questions. This produces an average increase of 9.6 questions. These score improvements ranged from 6 questions (28 to 34) to 17 questions (12 to 29). The nine students skipped a total of 91 questions on their first TABE compared to only 7 questions on their second TABE. Finally, their mean Rumsfeld Assessment Score increased from 72.9% to 79.2%; an average increase of 6.4%.

16: The subjects tested by both exams were the same even though the questions were completely different.

TABE – Applied Mathematics

37 TABE tests were administered. Since the test is merely an assessment there were no pass/fail criteria. The mean score was observed to be 26.1 correct questions out of a possible 50. The standard deviation was observed to be 9.4 correct questions. 30 of the 37 test-takers skipped at least one question. The mean Rumsfeld Assessment Score was 65.5%. Additionally we found that the correlation between the scores for the two sections of the TABE was about 0.764. The correlation between the Rumsfeld Assessment Scores for the two sections of the TABE was found to be 0.678. Both correlations are statistically significant for our 37 test-takers.

Furthermore, we found that the multivariate correlation between the two sections scores and the two sections Rumsfeld Assessment Scores to be about 0.779. The following table reports the breakdown of each question:

Question Number	Correct Answer	Most Common Wrong Answer	Number Correctly Answered	Number of Times Skipped
1	A	B[17]	32	2
2	G	F	29	1
3	D	A[17], B[17]	34	1
4	F	H	18	2
5	C	A[17]	34	0
6	H	G[17]	26	2
7	A	D[17]	22	8
8	H	J	20	4
9	A	C[17]	26	7
10	F	G	17	14
11	C	B[17]	33	1
12	G	F[17]	12	12
13	B	A[18]	10	5
14	H	G	14	2
15	B	A	18	9
16	J	F[17], G[17]	14	16
17	C	B	19	9
18	G	F[17]	33	2
19	B	A[17]	34	2
20	J	F[17], G[17]	35	0
21	A	D[17]	24	3
22	H	G	22	10
23	A	C[17]	16	6
24	G	F[18]	7	18
25	A	C[18]	8	15
26	J	G[17]	30	3
27	D	C[17]	32	1
28	H	F[17], G[17]	18	5
29	C	A[17], B[17], D[17]	24	1

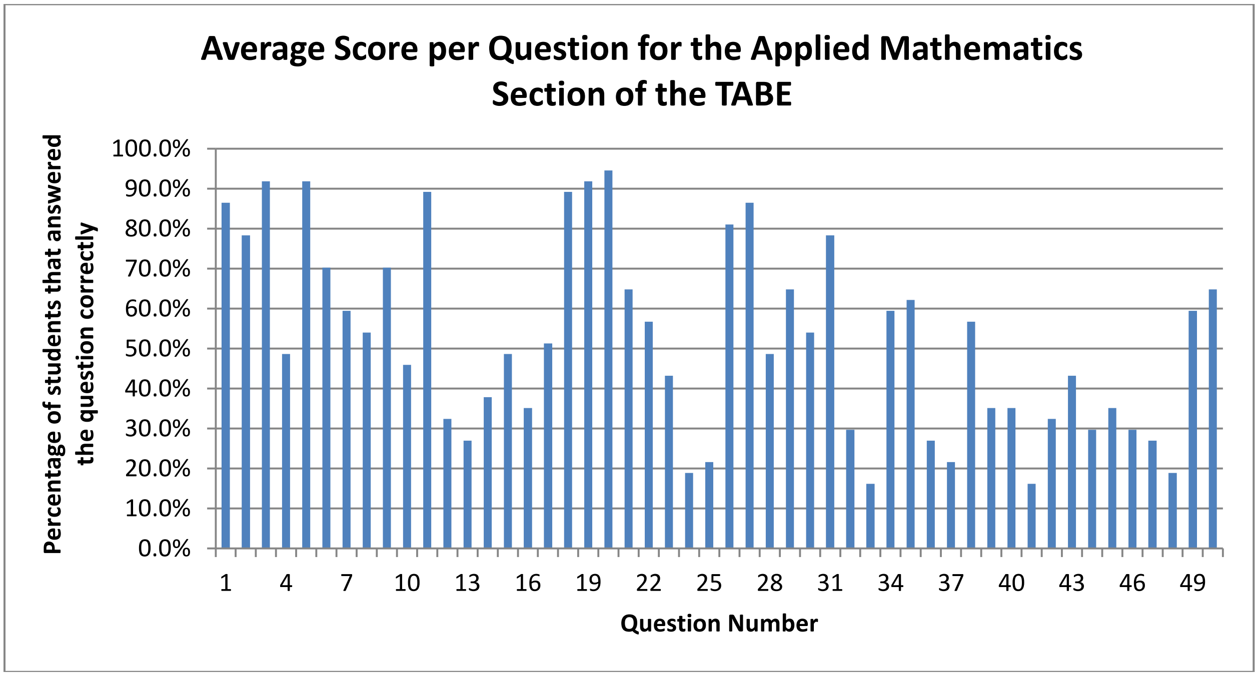
30	J	H	20	5
31	A	B	29	1
32	G	F	11	11
33	A	B[18]	6	9
34	J	F[17], H[17]	23	6
35	C	A	24	5
36	G	J	10	13
37	D	A[18]	8	11
38	G	H[17]	21	8
39	A	C[17]	13	17
40	H	J[17]	21	12
41	B	D[18]	6	16
42	H	G[17]	12	14
43	D	A[17]	16	8
44	G	J[17]	12	4
45	C	D[17]	14	15
46	H	J[17]	11	14
47	A	C[17]	10	19
48	F	J[18]	7	6
49	D	A	22	4
50	H	J	24	9

17: The incidence of choosing this incorrect answer is not significantly higher than the other incorrect answers.
18: The incidence of choosing this incorrect answer was higher than the incidence of choosing the correct answer.

Table 5 – Breakdown of each question on the Applied Mathematics Section of the TABE.

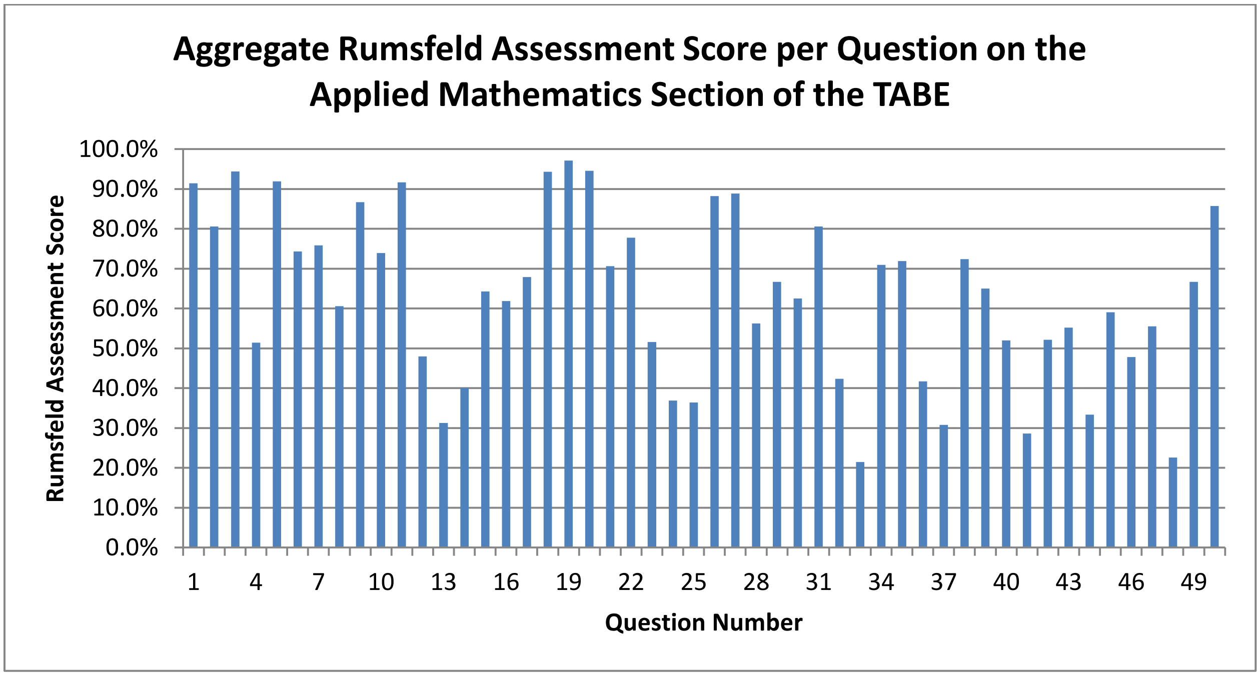
The following is a distribution of the average score for each question:

Figure 13



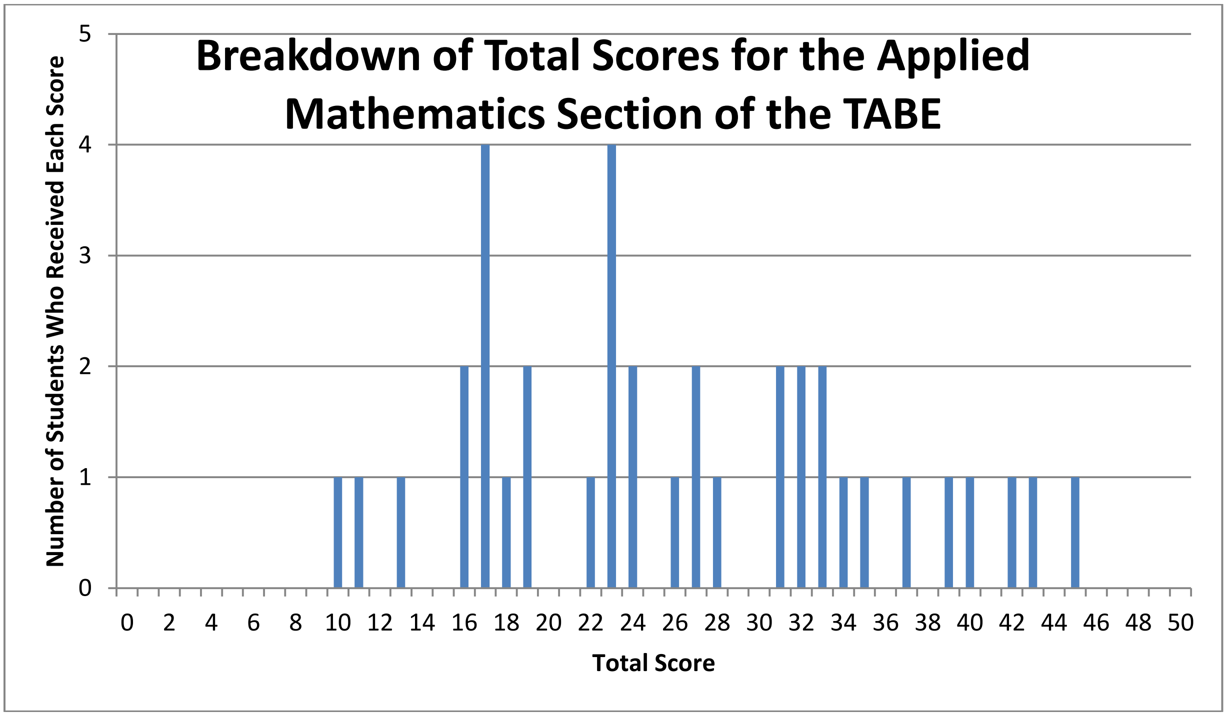
The following is a distribution of the aggregate Rumsfeld Assessment Scores for each question:

Figure 14



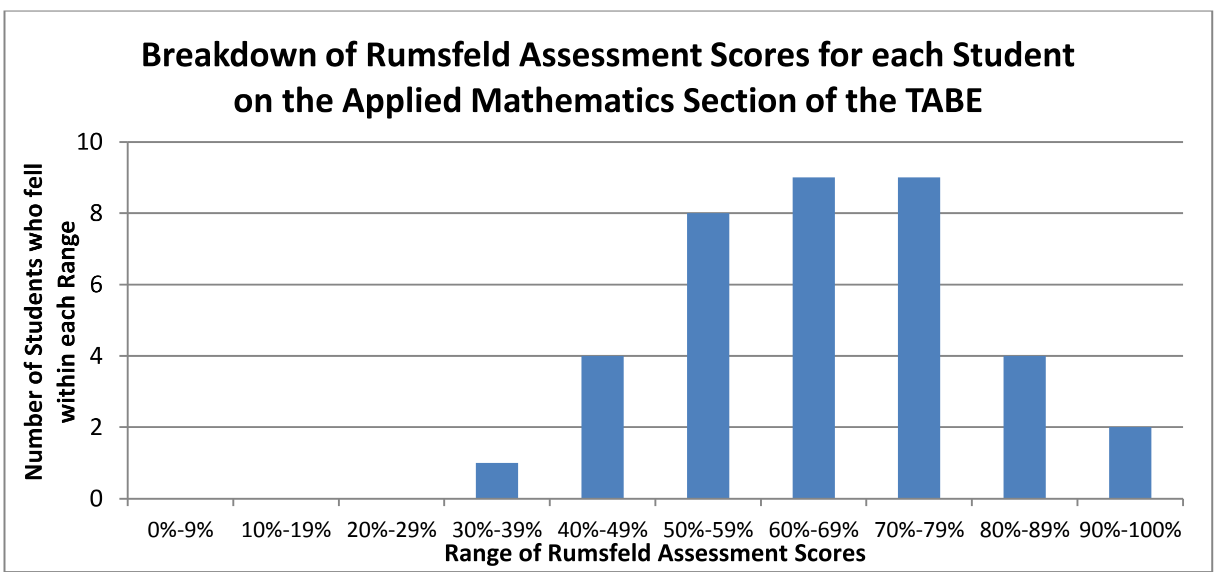
The following is a distribution of the total scores:

Figure 15



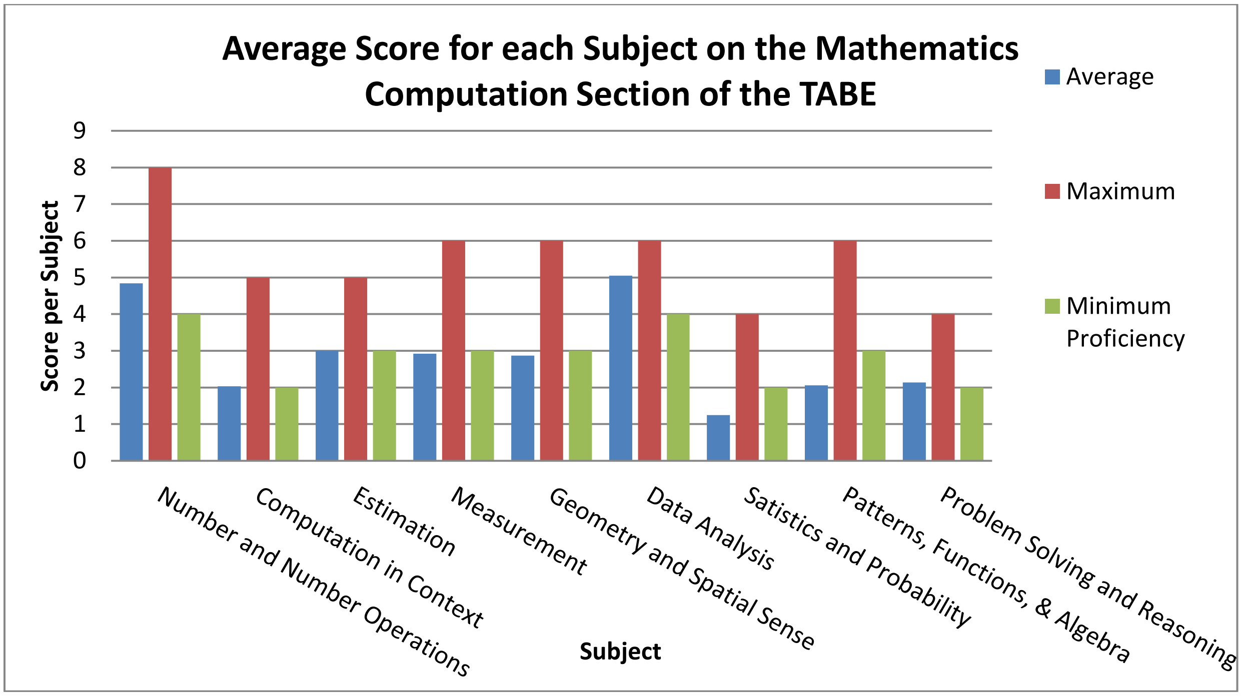
We can also look at the distribution of Rumsfeld Assessment Scores for each student:

Figure 16



Additionally, the TABE has a subject based breakdown of all of its questions. Here is a graph of the average score for each subject on the TABE-Computational Mathematics section:

Figure 17



Discussion on the CASAS

The data that we have collected on the CASAS reveal that our students, in general, have very poor math abilities. Furthermore, they have very poor direction following and critical thinking skills. Even though all students are not penalized for incorrect guesses, 43 of the 246 test-takers left at least one question blank. However, since none of our researchers witnessed a test being administered prior to May 2014, we cannot assume that test-takers were told that they will not be penalized for incorrect guesses. Also, from **Figure 1** we can see a negative trend for the question scores in relation to question number and from **Figure 2** we can see a positive trend in skipping in relation to question number. This could indicate that either the questions gradually increase in difficulty, or that the test-takers become mentally fatigued and/or disheartened as they progress through the test questions. Additionally, **Figure 3** reveals that the distribution of total scores adheres to the general shape of a normal distribution. However, it has a trimodal or multimodal structure.

When we examine the lowest scoring question, number 49, and its most common answer, we see that the majority of the test-takers chose 3 hours and 5 minutes as the correct answer. This means that most students mistook 2.65 hours to mean 2 hours and 65 minutes. This suggests both poor direction following and critical thinking skills. Hence, we need to develop curriculum that targets these areas as well as curriculum that involves counting in different bases.

The most common mistake on the second lowest scoring question also suggests poor critical thinking skills. We would not expect our students to know combinatorics; however this question is simple enough that a student can count each possible unique outfit individually. Instead, based on the most commonly chosen wrong answer, we can see that most test-takers simply multiplied the two relevant numbers that were provided in the question. This mistake not only shows a lack of understanding, but also a lack of patience. Hence, in addition to developing curriculum that targets direction following and critical thinking, we need to teach our students how to patiently set up and map out difficult and unfamiliar problems.

The most common mistake on the third lowest scoring question, number 46, also suggests impatience and a lack of critical thinking. The most common mistake indicates that most students simply recognized that the difference between a 2 inch door and 5 inch roof is 3 inches. They then falsely reasoned that the difference between a 7 foot door and its roof should also be 3; thus they chose 10 feet more commonly than 17.5 feet. Similar to question 50, we need to counteract this mistake by teaching our students to how to patiently set up and map out difficult and unfamiliar problems.

When we compare the three lowest scoring questions to the three highest scoring questions we observe a common theme. Questions, 26, 33, and 34 are all questions which only require decimal computations. Question 26 is a decimal addition problem, and question 33 and 34 require the test-taker to multiply a decimal by a whole number. The interesting observation arises when we compare the subject of these questions to the other questions. Computationally, questions 26, 33, and 34 are not much easier than the other problems involving decimal operations. However, the biggest difference between questions 26, 33, and 34 and the rest of the test is that the other questions involve some level of critical thinking. Even questions that are computationally much simpler than questions 26, 33, and 34 score significantly lower which can be attributed to the differences in critical thinking that is required for each question.

Recommendations for the CASAS

In general, we believe that a passing score of 12 out of 25 is far too low. Even though the chance of a student correctly answering 12 questions from "pure"[19] guessing is about 1.1%, the probability for correctly answering 12 questions is much higher for a mixture of guessing and not guessing. Consider the following: a student answers a certain number of the easiest questions correctly, using a method, and then guesses on the rest of the test. The probabilities of obtaining a score of at least 12 out of 25, in this way, are described in the following table:

19: Meaning that they did not eliminate any incorrect answer choices.

The Number of Questions Answered Correctly Using a Method	The Number of Questions that the Student Guessed on	The Necessary Number of Correct Answers Obtained from "Pure" Guessing	The Probability of Passing the Test from "Pure" Guessing
0	25	12	1.07%
1	24	11	2.13%
2	23	10	4.08%
3	22	9	7.46%
4	21	8	12.99%
5	20	7	21.42%
6	19	6	33.22%
7	18	5	48.13%
8	17	4	64.70%
9	16	3	80.29%
10	15	2	91.98%
11	14	1	98.22%

Table 6 – The Probabilities of Passing the CASAS from Guessing

As can be seen in this table, a student does not need to actually know very much material to have a decent probability of guessing their way to a passing score. Further consider **Table 2**, which reported the Relative Guess Scores. We can assume that since 6.25 is the expected Relative Guess Score for a student "pure" guessing on the entire test, students who received a 7, 6, or 5 have a high probability of mainly guessing; 15 students in total. Additionally, we can assume that students who received a Relative Guess Score of 3 or 4 guessed on a considerable number of questions; 63 students in total.

Our recommendations to counteract this problem are the following:

1. Add answer choices
    - Simply adding an answer choice to each question can drastically reduce the probability of a student correctly guessing their way to a passing score.
2. Increase the threshold for a passing score
    - Clearly increasing the threshold for passing any test will make it harder for students to pass regardless of whether they mainly used a method or guessed.
3. Add more questions
    - Increasing the threshold for a passing score may seem harsh or counter-productive. As an alternative, the CASAS could also be re-written to include more questions and be a better analysis of abilities.

Simply adding questions, while still maintaining the 48% ratio needed for passing, would drastically reduce the probabilities of students being able to guess their way to a passing score.

Discussion on the CASAS Level-Set

It is concerning that only 9 of the 33 students who took the CASAS Level-Set received a passing score. Additionally, of those 9 students who passed, 7 received exactly a passing score, while only 2 students exceeded passing. In contrast, only 1 of the 33 test-takers skipped at least one question, indicating that most of the students followed the directions properly. We acknowledge that poor overall performance is somewhat expected considering that all of the students who took the CASAS Level-Set, failed the regular CASAS. On the other hand, we must also consider the fact that a higher score, 25 out of 31, is needed to pass the CASAS Level-Set compared to the CASAS. We recognize that this higher ratio is most likely due to the fact that the questions in the CASAS Level-Set are, on average, computationally simpler than the regular CASAS. However, many questions in the CASAS Level-Set require the same amount of critical thinking, or in some cases much more critical thinking. As we have demonstrated previously, critical thinking is a problem with many of our students.

The four lowest scoring questions were numbers 5, 6, 28 and 29. 5 and 6 are extremely similar questions. They are simply the addition and subtraction of fractions with different denominators. Computationally these types of questions can be fairly simple, however in order to answer them correctly a student would need to know the proper method. Therefore, we can assume that the students who answered these questions incorrectly did not know the correct method for calculating the answer. Unfortunately, the most common incorrect answer for question number 5 would be the answer obtained by adding the two fractions together, instead of subtracting one from the other. This is unusual since this would suggest that about half of the students who took this test mistook a subtraction sign for a plus sign, on this question and only this question. When we look at question number 6 we see that the most common incorrect answer occurs when a student adds both numerators and denominators together, a mistake that also commonly occurred on the regular CASAS. In total, eleven students chose the answer for question 5 that would result from correctly executing addition, and then chose the answer for question 6 that would result from incorrectly adding both numerators and denominators together. The only explanation is that the students who chose answer choice C executed a weighted guess and reasoned that choice C looked like it could be the right answer.

We see a similar problem with question number 28. This question requires students to calculate the volume of a rectangular prism, something that most students would not be able to figure out on their own. The most common incorrect answer can be explained by students simply adding of the given numbers together. This common mistake is most likely the result of students confusing the concepts of perimeter, area, and volume. Additionally, this common mistake reveals a level of impatience, similar to questions 46 and 50 on the regular CASAS.

Lastly, we have question number 29, which is computationally the most complicated question on the test. Students are required to add up the value of all of the items on the receipt and then calculate the necessary tax. The most common incorrect answer was clearly the result of students simply converting the sales tax rate of six percent into a decimal. This shows that at least these students knew what the word “percent” might mean, but it also shows that they do not know the computational steps necessary to correctly answer the question.

The three highest scoring questions were numbers 1, 11, and 22. Computationally these questions were very simple and required almost no critical thinking skills.

Recommendations for the CASAS Level-Set

Our recommendations for the CASAS Level-Set test coincide with our recommendations for the regular CASAS test. We believe that the difference between the passing grades for the CASAS Level-Set and regular CASAS is too large. We recognize that that the higher score, necessary for passing the CASAS Level-Set is most likely due to the fact that the questions in the CASAS Level-Set are, on average, computationally simpler than the regular CASAS. However, many questions in the CASAS Level-Set require the same amount of critical thinking, or in some cases much more critical thinking. As we have demonstrated previously, critical thinking is a problem with many of our students. Hence, we would recommend more computation centered questions.

Also, it is obvious that the areas that students have the most trouble with on the CASAS Level-Set can be corrected with instruction. It is our recommendation that each student complete some sort of math instruction before taking the CASAS Level-Set. This instruction can be in the form of an in-person class, one-on-one tutoring, or online instruction such as Khan Academy.

Discussion on the TABE Computation Section

The three lowest scoring questions on the Computations Section of the TABE were questions 33, 34, and 39. Question number 39 was the third lowest scoring question overall, but it had the lowest aggregate Rumsfeld Assessment Score (25%). This means that students were more over-confident on question 39 than any other question. On the surface, question 39 looks no different than question 37. However, question 37 has a much higher overall score and Rumsfeld Assessment Score. The only explanation for this discrepancy is that the majority of the students who took TABE were confused by the combination of negative and positive numbers in question 39. Whereas question 37 had a subtraction problem involving two negative numbers, which resulted in a problem that was easier for our students to conceptualize. Additionally, the most commonly chosen wrong answer on question 39 resulted from students confusing the negative three with the positive three and reasoning that any number subtracted by itself is simply zero.

Questions 33 and 34 are very similar problems. We can see from the high number of students who skipped these questions, that many students were intimidated by the fractions. Other questions, which involved fractions, such as questions 21, 24, and 31, also had low overall scores and a high incidence of skipping. These low scores show that a large number of our students do not know the proper methods for fraction operations, which is consistent with our findings from the CASAS and CASAS Level-Set tests.

Questions 1, 2, and 9 were the highest scoring questions. They all involve decimals, which is consistent with our findings from CASAS and CASAS Level-Set, that most students are fairly comfortable with decimals. Also, our subject-based breakdown of the Computations Section of the TABE revealed that our students are less than proficient with fractions, percentages, and negative integer operations.

Recommendations for the TABE Computation Section

Compared to the CASAS, which requires students to use multiple mathematical skills simultaneously, we believe that the TABE is a better assessment test to be used as an entrance exam. Alternatively, the TABE can be used in concert with the CASAS. Upon examination the questions on the Computations Section of the TABE, it is evident that it is better assessing mathematical skills in each particular area. For instance, it is clear from our subject based breakdown of the score for the Computations section of the TABE that Fractions and Percentages require the most improvement for most students. Additionally, the TABE offers a more equitable balance between each subject. Hence, we would recommend that the CASAS be rewritten to resemble this style of test.

Furthermore, our recommendations are that future instructional curriculum should focus on the lowest scoring areas of the Computations Section of the TABE. Such curriculum was implemented, for nine students, and their progress was tracked by administering an additional TABE exam upon their completion of the four week course. The results of this test were reported above and will be discussed below.

Discussion on the TABE Computation Section for Nine Select Students

Nine of the students who took the Computational Mathematics section of the TABE, spent approximately three weeks in one of our mathematics classes, and then took the same section of another TABE exam.[20] We saw significant improvement from all nine students, which is expected. Almost every student improved in every area of the test. Primarily, we saw a large improvement in the subject of Fractions, which was our main area of focus. The average improvement in the area of Fractions was 3.778 questions. Additionally, our other two areas of focus were Negative Integer Operations and Percentages, which had average improvements of 2.111 and 1.111 respectively. This shows how effective a brief and focused instruction method can be in improving student competency for key subjects.

Discussion on the TABE Applied Mathematics Section

The four lowest scoring questions on the Applied Mathematics section of the TABE were question numbers 24, 33, 41, and 48. Question 33 was the lowest scoring question and also had the lowest aggregate Rumsfeld Assessment Score. This means that students were more over-confident on question 33 than any other question, and that question 33 was also the most difficult question on this portion of the test. The question requires students to know what a trapezoid, rectangle, square, and rhombus are, and also what parallel means. However, since all of the above shapes have at least one pair of parallel sides, one must also need good critical thinking and reading skills to find the one shape that has one and only one pair of parallel sides. The most common answer choice was “rectangle”. We suppose that either the students who chose this answer choice did not read the question carefully, or that these students were more familiar with

20: The subjects tested by both exams were the same even though the questions were completely different rectangles compared to rhombuses and trapezoids.

Question 41 is another geometry problem, this time asking the perimeter of a rectangle. We can see from the most commonly chosen wrong answer that students frequently confuse perimeter with area, or at least the formula necessary for calculating them. Also, question 48 is a geometry problem. Question 48 requires knowledge of Cartesian coordinates, and the standard convention for recording them.

Considering that 3 out of the 4 lowest scoring questions on this section of the TABE all involve geometry, instruction in geometry is advised, starting with basic geometric concepts.

Question 24 involves fractions and reducing fractions into lowest terms. Specifically, test-takers are required to determine the number of voters that voted for a specific candidate, and what fraction that constituted, out of the total number of voters. This common problem replicates our previously established findings, that our students generally have a hard time with fractions.

Questions 3, 5, 19, and 20 were the highest scoring questions. Computationally these were very simple questions, and they required very little critical thinking.

Recommendations for the TABE Applied Mathematics Section

As we can see from the graph of average score for each subject on the Applied Mathematics section of the TABE, the Patterns, Functions and Algebra questions, and the Statistics and Probability questions require the most improvement. Hence, some instruction is needed in these areas. However, since our programs do not require competency in these subjects, instructing students in the subjects of Patterns, Function and Algebra and Statistics and Probability are not that important. On the other hand, Geometry and Measurement were the third and fourth lowest scoring subjects on this section of the TABE, and they are extremely relevant to the classes offered here. Hence, extra instruction in the areas of Geometry and Measurement is highly advised.

Conclusions

CASAS, CASAS Level-Set, and TABE Assessments

A major hindrance to students wishing to enter the programs is the CASAS entrance assessment.

Although the data are incomplete for the attrition rate associated with students failing the CASAS on their first attempt, an initial estimate put this number at around 50%. This means that for every 2 students that walk in the door, 1 stays. A key purpose of this report was to address why this was occurring and how to remedy it. **Our major findings also suggest that as it is currently being used, the CASAS has too low of a passing score, is too slanted towards certain types of math, and needs to be re-structured in order to abate the likelihood of passing from guessing.**

The CASAS Level-Set is also problematic in that the method of testing students' mathematical abilities is not focused enough on computationally-driven questions. Indeed, the bulk of the questions on the CASAS Level-Set are based on critical reasoning skills, which, in the absence of a good foundation of computational abilities, will be very difficult for our students. That is to say, students must learn how to carry out basic mathematical computations before they can be expected to reason their way through more complicated math problems.

Another purpose of this report was to determine if a secondary assessment, the TABE, would be a better fit for assessing students' mathematical abilities, and also the role that it could play in providing ongoing mathematical assistance for students in the programs. The TABE comes in a pre- and post-form to be given before and after mathematical assistance, respectively. In this way, it serves as a more effective gauge of students' mathematical abilities and how these may have changed over the course of receiving such assistance.

In general, all of the students who both took the pre- and post-TABEs and received mathematical assistance from the math lab increased their scores, and in some cases improved them exceptionally. This suggests that investing in mathematical resources for students would improve both student retention and overall program success.

PART II

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PART II

SECTION I

DESCRIPTION OF STUDY

Introduction

As has been recognized, mathematics forms a crucial part of the foundation for all of our students at Marion Shadd. In particular, the construction trades require an understanding of mathematical knowledge that is not only academic but applied as well. In light of this, we began offering students supplemental mathematics assistance beginning April 2nd. The purpose of the mathematics assistance was to remediate deficiencies in core mathematical areas as identified through the CASAS and TABE assessments.

Students were sourced primarily from post-CASAS sessions. That is, students who scored below a 221 were asked if they wished to receive assistance before attempting the Level-Set. Students who scored between a 221 and a 231 were also asked if they wished to receive additional assistance. Students above a 231 were generally not asked if they wished to receive assistance.

Students were also taken in by referral from other staff on site and via phone calls. Most students were required to take the TABE in order to be eligible to receive mathematical assistance (even with a CASAS score on record), but we also had students come solely for CASAS Preparation who did not receive additional mathematical assistance.

Overview of Contact-Hour Delivery Modes

For the data collection period, there were 5 modes of student assistance. These modes have been developed over the course of the last few months and each mode presented strengths and weaknesses for our students.

One-on-One

In One-on-One instruction, students are assisted alone.

Strengths

- Attention to individual students is maximized
- Students are able to voice concerns and suggestions as the session progresses
- Some students are more confident when working alone

Weaknesses

- Sessions can become lengthy and inefficient

- Contact-hours are distributed over several sessions instead of one session (such as in a workshop)
- Students may lose confidence since there are no other students with which to work

Learning Partner

Learning Partner instruction is instruction that is carried out with two students simultaneously.

Strengths

- Learning partners often help each other to understand the material
- Students have a sense of solidarity and improved confidence when working with others at the same skill level
- Contact-hours are more concentrated relative to One-on-One instruction

Weaknesses

- Differentiated skill levels can become problematic if one student is not willing to assist the other
- Students may disagree on what material to work on next during a session
- Students entering or leaving sessions at different times can create tension for remaining learners

Small Group

Small Group instruction relies on groups of 3 to 5 students working together.
Strengths

- Opportunities for students engaging in group leadership are greater than with One-on-One or Learning Partner modes
- Contact-hours are ideally concentrated for the instructor since the group is neither "too large" nor "too small"
- Student diversity in skills allows multiple students to help the group

Weaknesses

- Maintaining student interest (particularly for a larger group) can be a challenge
- Differentiated skill levels can become unacceptably pronounced
- Reaching consensus on the direction of the session can be difficult

Lecture

Lectures are the most “traditional” mode of instruction and the one most students are probably used to working within, i.e. large group

Strengths

- Contact-hours are maximized for each session
- The curriculum for a given session can be standardized, establishing a paradigm of objective performance evaluation
- The direction of the session is set, without much opportunity for getting sidetracked

Weaknesses

- Individual student attention is weakened by virtue of the class size
- Maintaining interest is difficult with large groups of students
- Students that want to help other students may be scared of doing so

Workshop

Workshops are a combination between One-on-One, Learning Partner, or Small Group modes and a Lecture. Workshops are generally less theoretical and more applied.

Strengths

- Detailed attention can be given to applications of theoretical knowledge
- Students are able to see the connection between “the math” and real life
- Students may feel more confident once they see that math is not just something in a book but a critical job skill

Weaknesses

- Workshops can get side-tracked easily since students often want to see more applications of a particular theory or concept
- Student input into the curriculum is weak
- Real-life applications can confuse some students who are used to drills and worksheets when using math

Programmatic Concerns with Content

Many of the concerns regarding the availability of supplemental mathematical assistance stem from the disconnect between students’ construction coursework and math related to and presented in relation to their respective fields. For this reason, we aimed to mold our curricula to fit within the context of a construction field setting. Many of our problem sets and examples were based on various construction site applications, such as framing, material estimating, area estimation, etc…

As of the time of this writing, there have been preliminary efforts to source and develop a "Construction Mathematics" course based on the NCCER textbook *Applied Construction Math Trainee Workbook*. We highly recommend pursuing this plan since this book has been produced specifically with construction-based applications in mind.

Statistics Relating to Contact-Hour Delivery Modes

For a given session, the following key pieces of information were recorded:

- Student name
- Session begin and end times
- Length of session (hours, discretized to 15 minute intervals)
- Date of session and day of the week
- Subjects covered (as categorized by the TABE assessment plus the categories of CASAS Prep and Other)
- Type of Help (One-on-One, Learner Partner, Small Group, Lecture, or Workshop)

Sessions were recorded based on the change of learning mode. For example, if Student A began working with us alone at 3 P.M. and then at 3:30 P.M. Student B joined the session until 4 P.M. when both students left, then the first session (3 – 3:30) would have been recorded as "One-on-One" for Student A, and the second session (3:30 – 4) would have been recorded as "Learning Partner" for both Student A and Student B.

Sessions were also recorded as split if multiple subjects were covered with the order of subjects not mattering.

For a given session, the material covered was categorized into one of the following (all from the TABE assessment plus the categories of CASAS Prep and Other):

- Multiplication of Whole Numbers
- Division of Whole Numbers
- Integers
- Fractions, Decimals, and Percents
- Number and Number Operations
- Computation in Context
- Estimation
- Measurement
- Geometry and Spatial Sense
- Data Analysis
- Statistics and Probability
- Patterns, Functions, and Algebra
- Problem Solving and Reasoning
- CASAS Prep
- Other

"CASAS Prep" involved working through any material directly drawn from the CASAS booklet, Form 130. "Other" involved any other mathematical topics, such as Pre-Calculus, Electronics Math, HVAC Math, etc…

PART II

SECTION II

KEY STATISTICS

Introduction

In analyzing the data, students were categorized into "Consistent Students" and "Inconsistent Students". Consistent Students were defined as students who attended 5 or more sessions with the Math Help Room. Inconsistent Students were defined as students who attended 4 or fewer sessions with the Math Help Room.

The reason students were categorized in this way was that students were generally encouraged to attend repeated sessions instead of coming to fewer sessions (and potentially having these fewer sessions entailing longer contact-hour time).

Study Parameters and Data

Observation Period: **April 17th – July 30th** (excluding Fridays and Weekends)

Total Unique Students Served: **38**

Total Sessions: **186**

Total Contact-Hours: **183.25**

Mean Contact-Hours/Week: **~ 12.22**

Total Consistent Students: **11 (~ 29% of students served)**

Total Inconsistent Students: **27 (~ 71% of students served)**

Attendance Parameters

Minimum Number of Sessions	1
Maximum Number of Sessions	36
Range of the Number of Sessions	35
Median Number of Sessions	2
Mean Number of Sessions	4.89
Std. Dev. of the Number of Sessions	7.10

Table 1.A – Parameters of the Number of Sessions for All Students.

Minimum Number of Sessions	5
Maximum Number of Sessions	36
Range of the Number of Sessions	31
Median Number of Sessions	6
Mean Number of Sessions	12.27
Std. Dev. of the Number of Sessions	9.75

Table 1.B – Parameters of the Number of Sessions for Consistent Learners.

Minimum Number of Sessions	1
Maximum Number of Sessions	4
Range of the Number of Sessions	3
Median Number of Sessions	2
Mean Number of Sessions	1.89
Std. Dev. of the Number of Sessions	0.96

Table 1.C – Parameters of the Number of Sessions for Inconsistent Learners.

Contact-Hour Parameters

Minimum Number of Contact-Hours	0.5
Maximum Number of Contact-Hours	32.75
Range of the Number of Contact-Hours	32.25
Median Number of Contact-Hours	2.63
Mean Number of Contact-Hours	4.82
Std. Dev. of the Number of Contact-Hours	6.29

Table 2.A – Parameters of Contact-Hours for All Students.

Minimum Number of Contact-Hours	3.75
Maximum Number of Contact-Hours	32.75
Range of the Number of Contact-Hours	29
Median Number of Contact-Hours	8
Mean Number of Contact-Hours	11.30
Std. Dev. of the Number of Contact-Hours	8.64

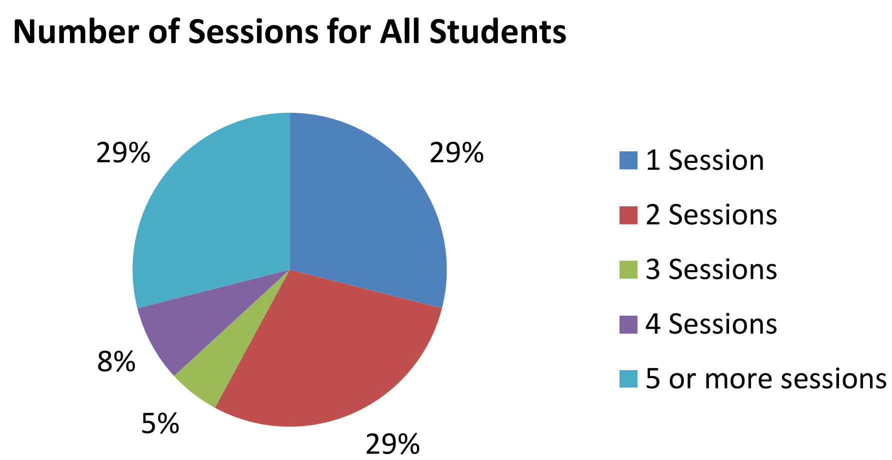
Table 2.B – Parameters of Contact-Hours for Consistent Students.

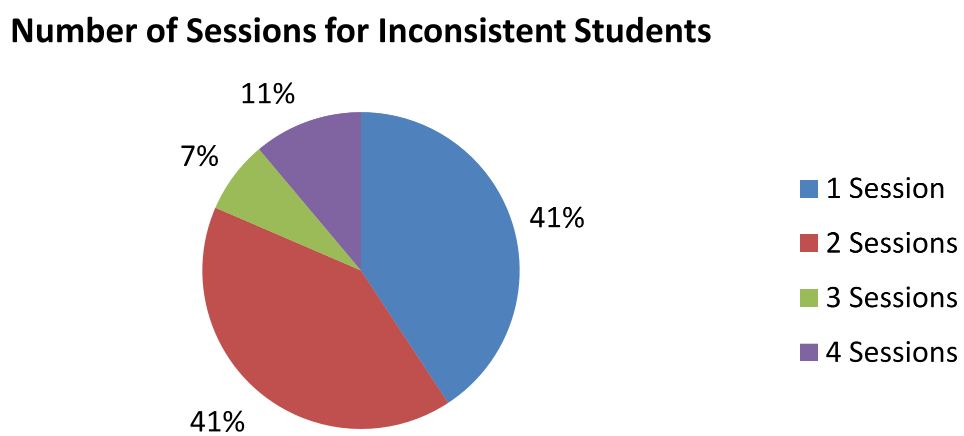
Minimum Number of Contact-Hours	0.5
Maximum Number of Contact-Hours	4.5
Range of the Number of Contact-Hours	4
Median Number of Contact-Hours	2
Mean Number of Contact-Hours	2.19
Std. Dev. of the Number of Contact-Hours	1.12

Table 2.C – Parameters of Contact-Hours for Inconsistent Students.

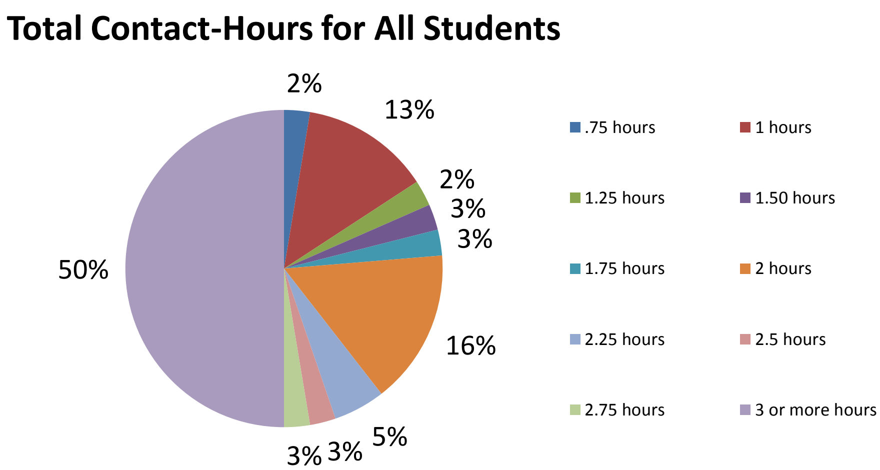
Graphics

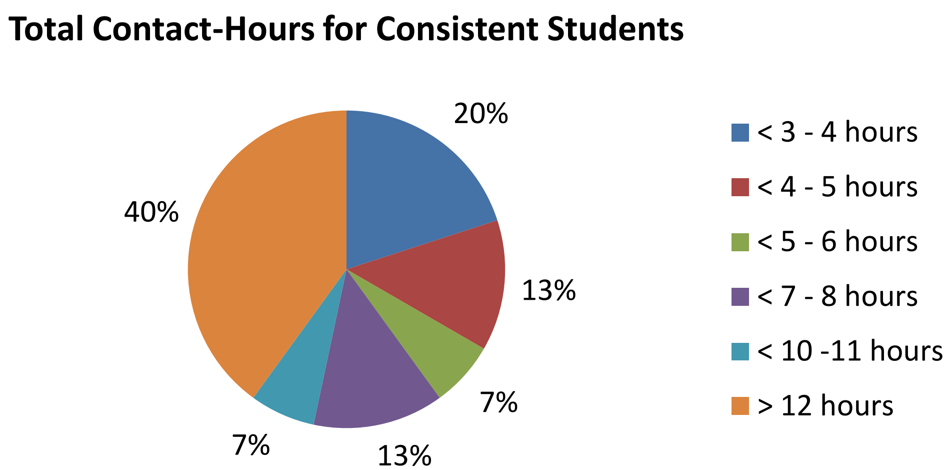
Graphic 1 – Number of Sessions

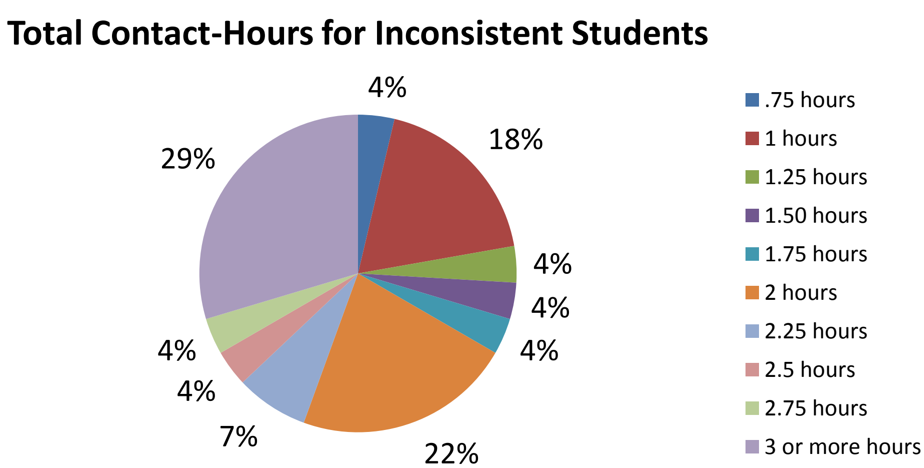




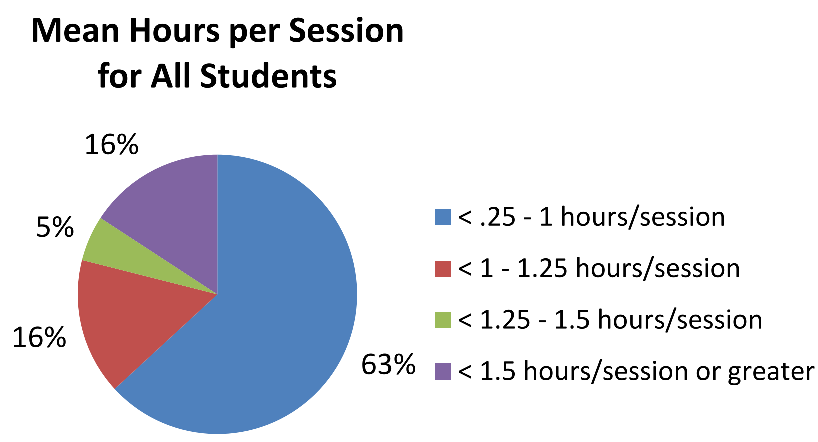
Graphic 2 – Total Contact-Hours

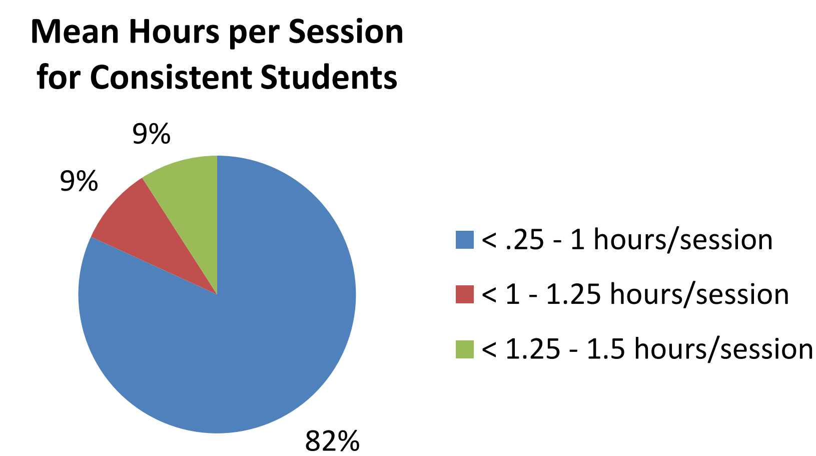


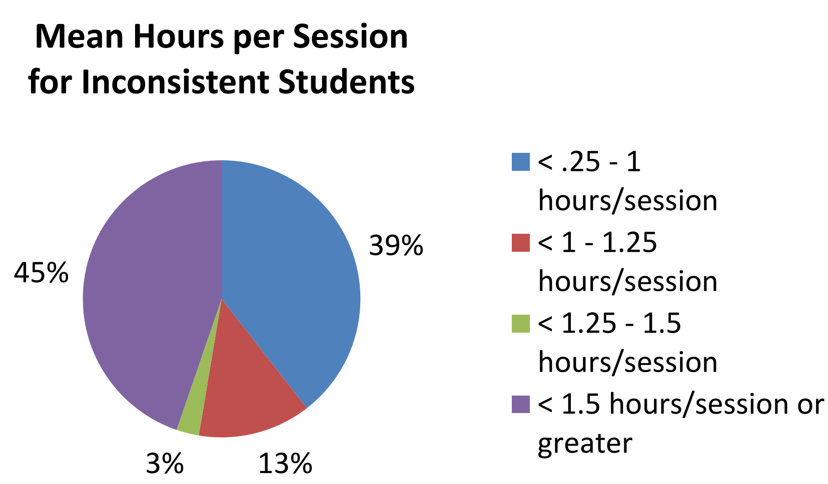




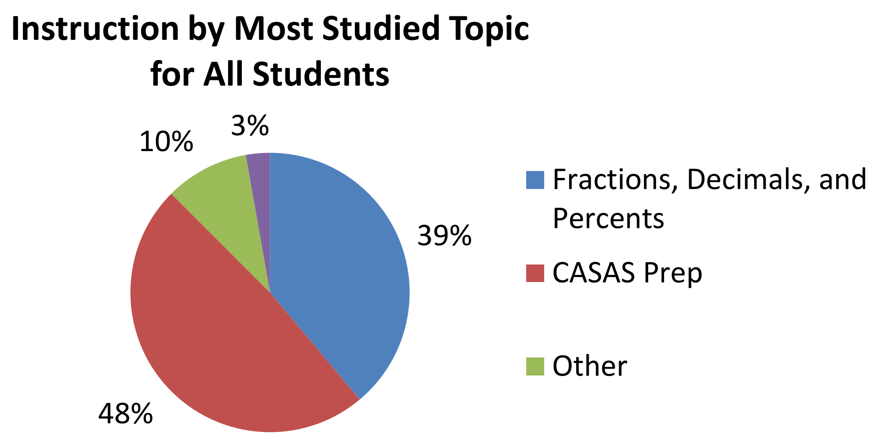
Graphic 3 – Mean Hours per Session

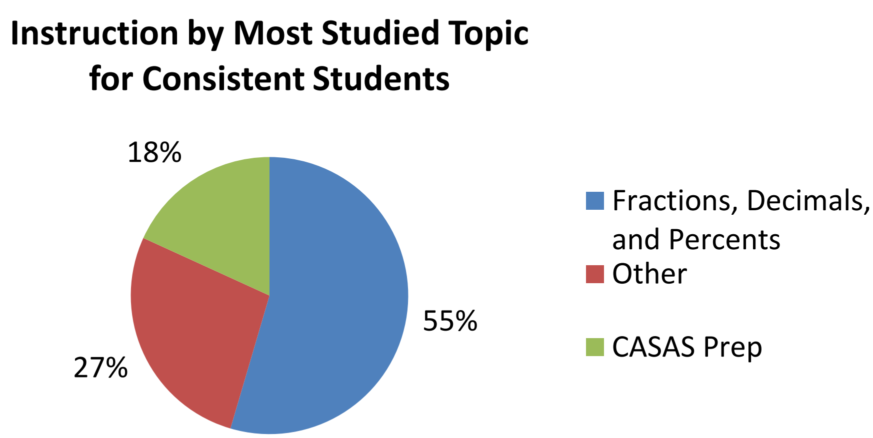


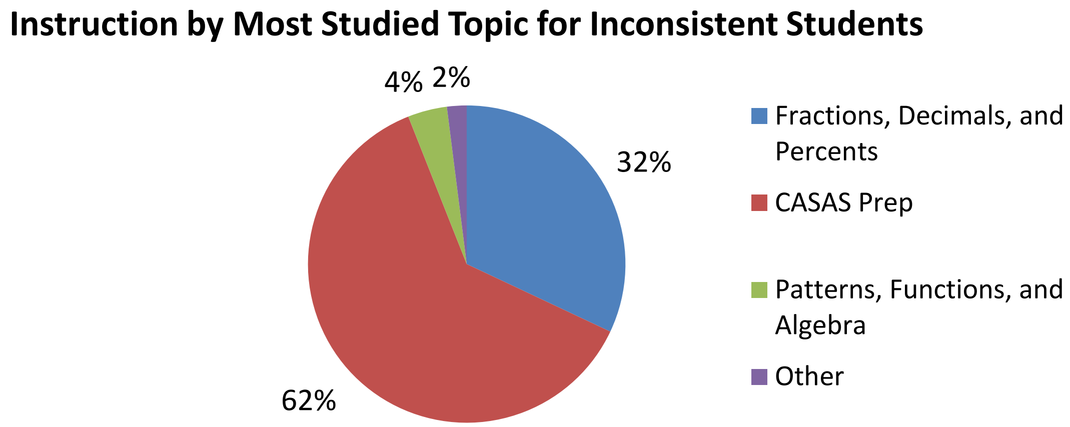




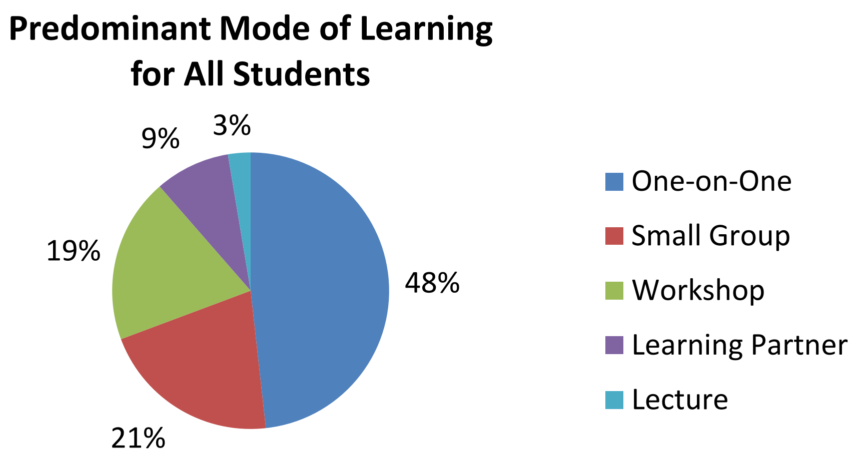
Graphic 4 – Most Studied Topic

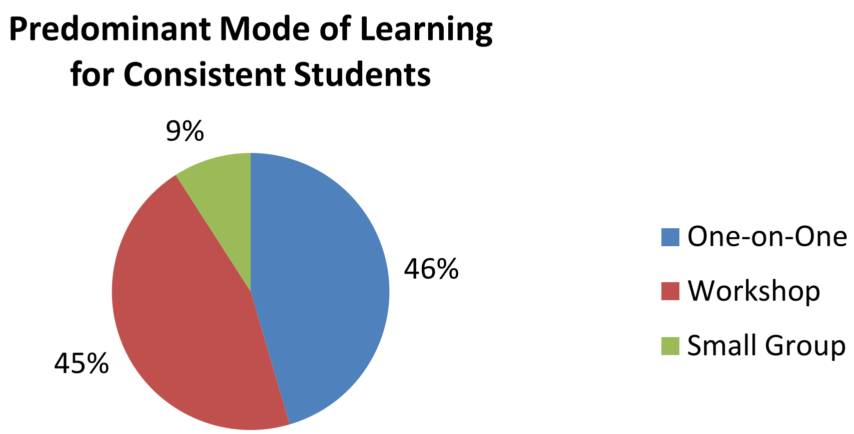


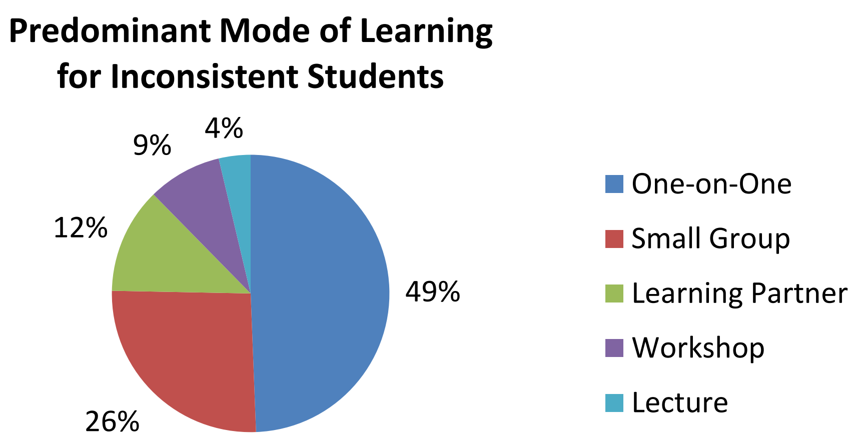




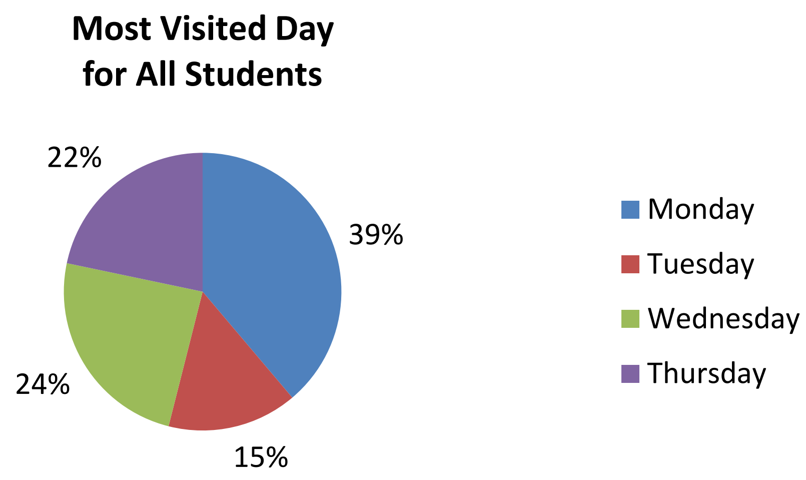
Graphic 5 – Predominant Mode of Learning

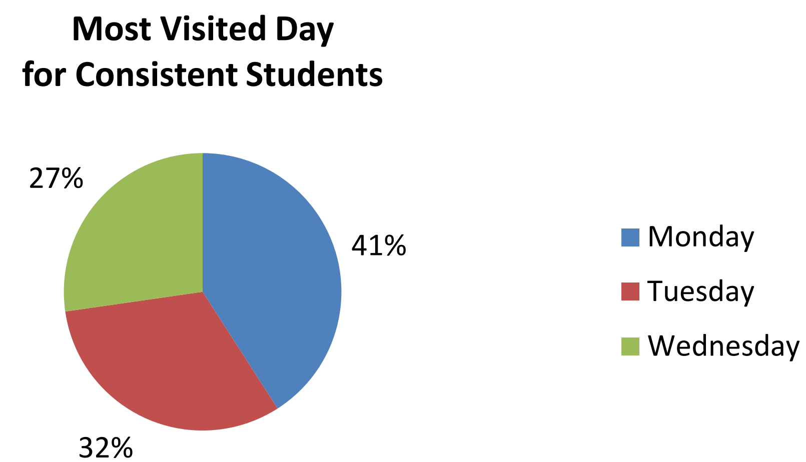


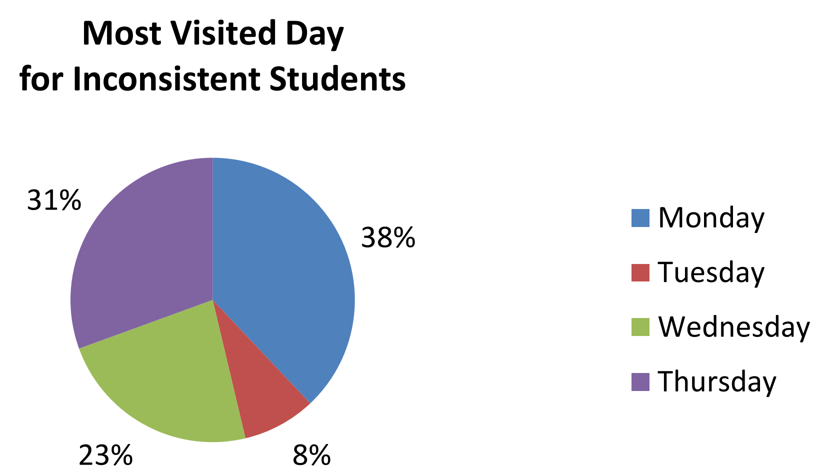




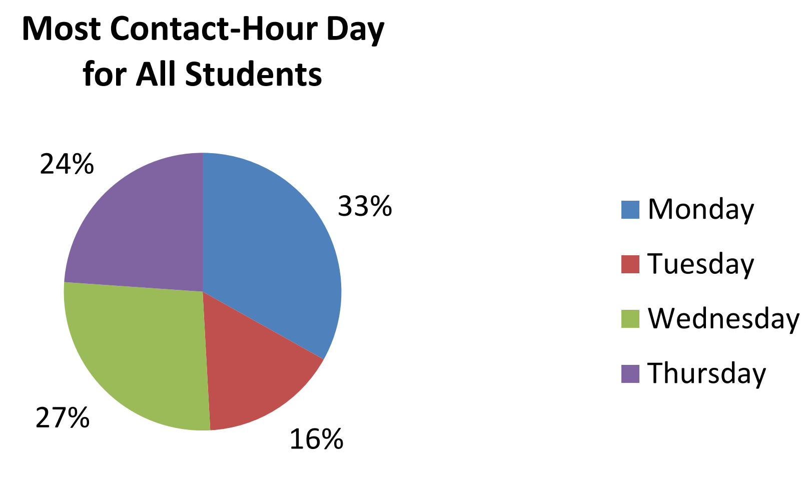
Graphic 6 – Most Visited Day

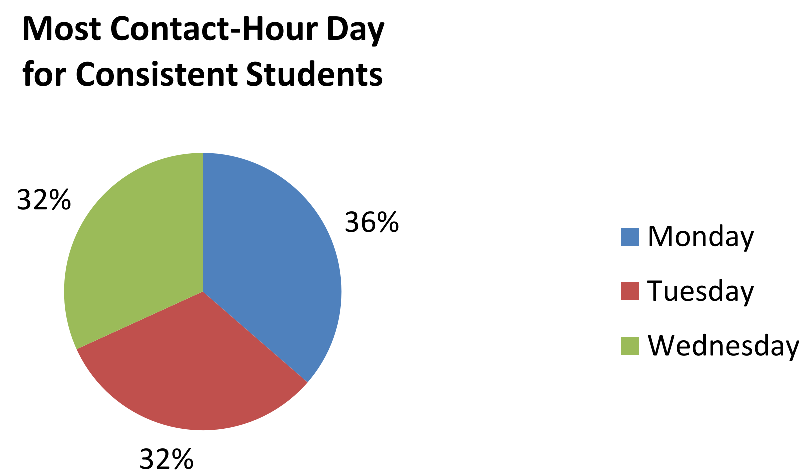


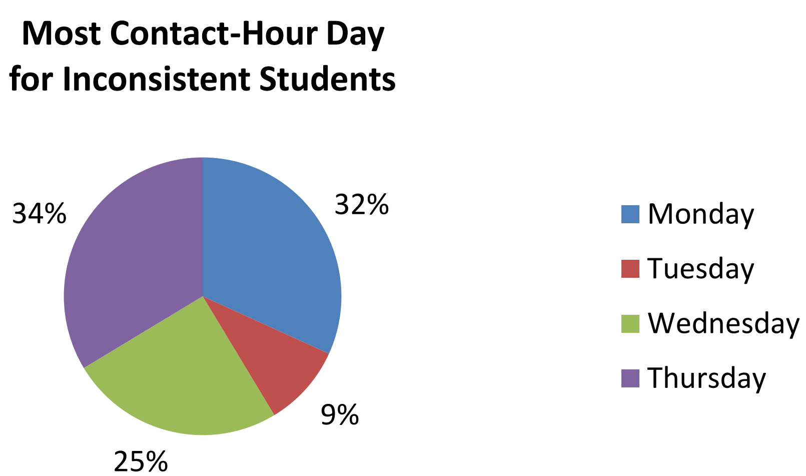




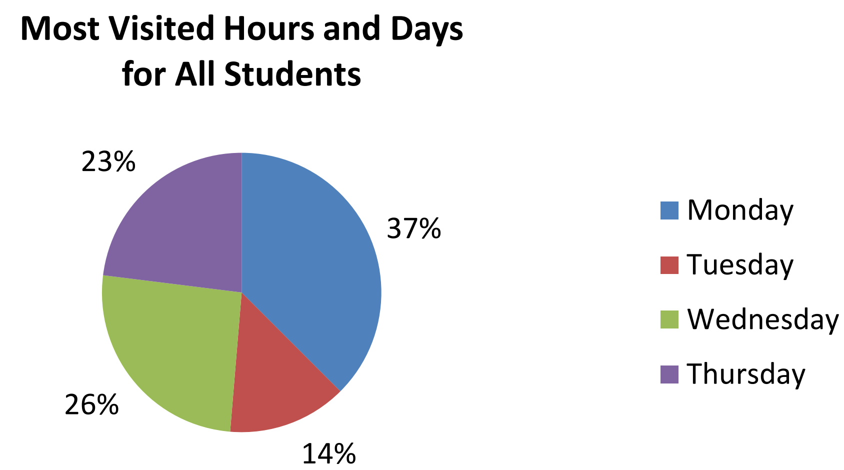
Graphic 7 – Most Contact-Hour Day

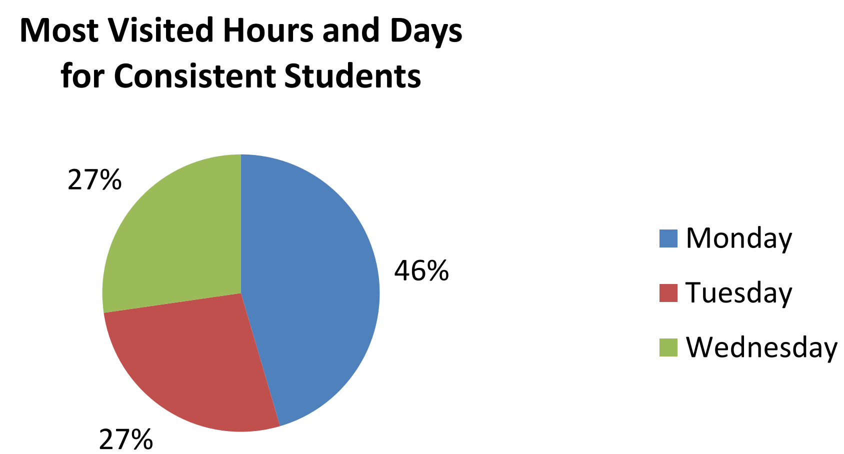


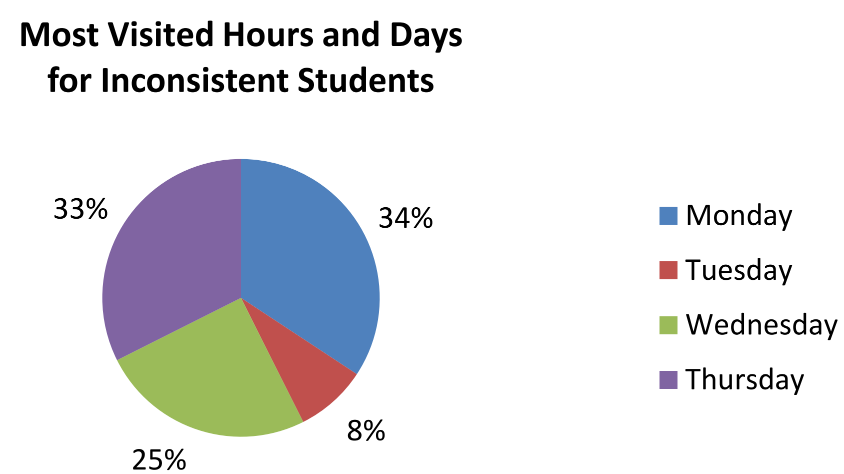




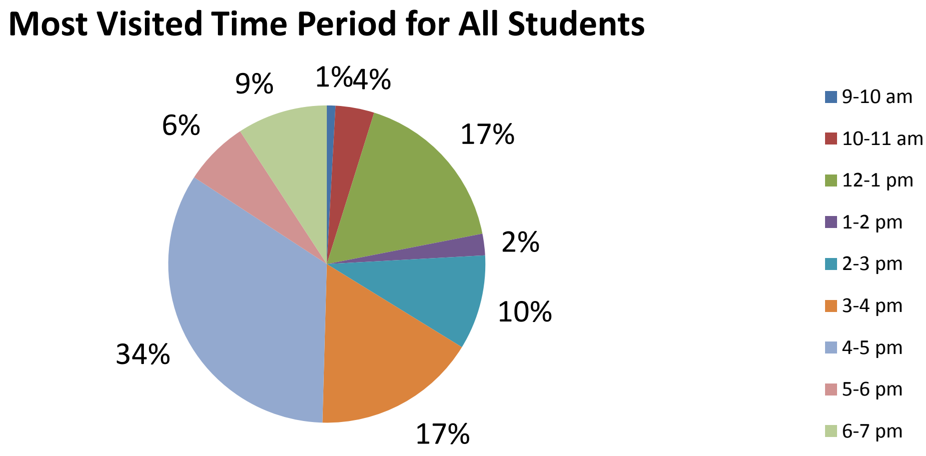
Graphic 8 – Most Visited Hours and Days

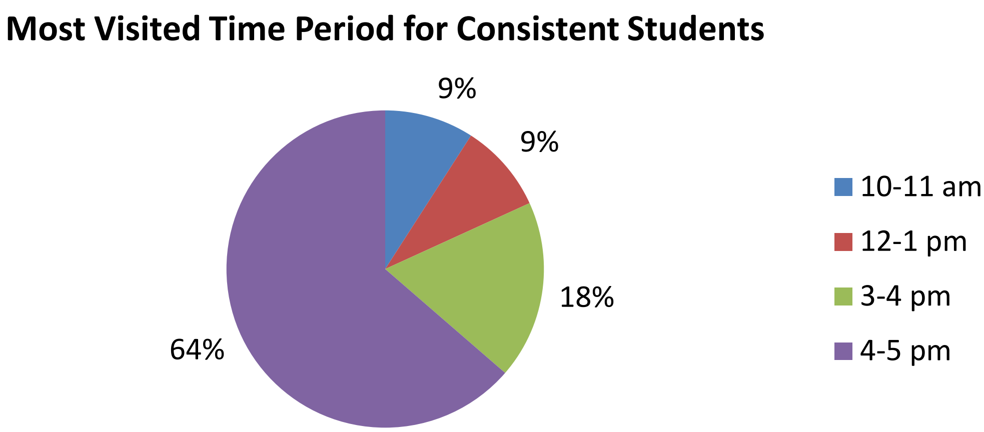


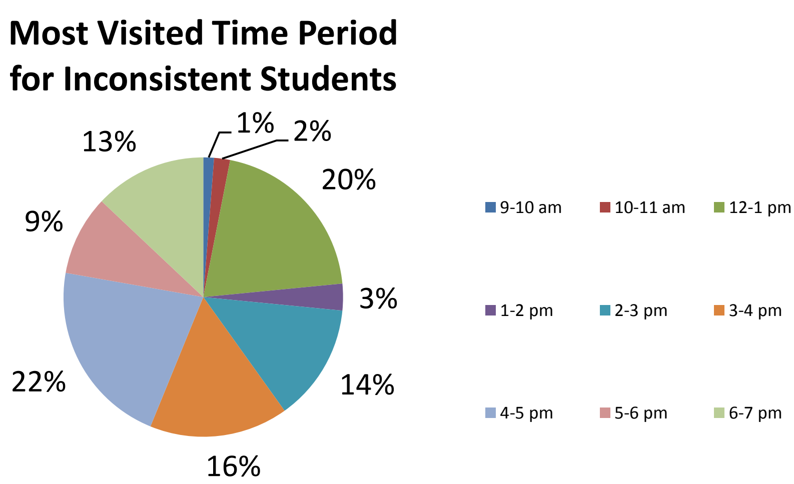




Graphic 9 – Most Visited Time Period







PART II

DISCUSSION OF KEY STATISTICS

Major Characteristics of All Students – Reporting on the 3 largest clusters unless 4th was present by percentage split

Number of Sessions

29% of learners coming to the Math Lab came for 5 or more sessions, with another 29% of students coming to only 2 sessions, and 29% of students coming to 1 session. This indicates that students fell relatively neatly into two major clusters. The first was students who showed sustained interest in receiving mathematical assistance as indicated by their attendance at 5 or more sessions, the “Consistent Learners”. The second cluster was those showing up for 1 or 2 sessions. This second cluster’s reasons for low attendance could have been that they only needed a little bit of help, or perhaps they lost interest.

Total Contact-Hours

50% of our students came for 3 or more contact hours, followed by 16% coming for 2 hours, and 13% coming for 1 hour.

Of the consistent students, the largest attendance group was those coming for 12 or more hours, at 40%, followed by those coming for between 3 and 4 hours (20%), and lastly those coming between 4 or 5 hours and those coming between 7 and 8 hours (13% each).

As for the Inconsistent Students, there were three major clusters. The largest cluster was students coming for 3 or more or hours (29%), followed by 2 hours (22%), and then 1 hour (18%). Similarly to the data on Number of Sessions, these statistics indicate that students may have come for a session or two and spent a total of 1 or 2 hours and then moved on; this was often the case with students coming solely for CASAS Prep. However, some students also spent a considerable amount of time concentrated in 1 or 2 sessions on CASAS Prep. This statistic is supported by the discussion that follows.

Mean Hours per Session

Our overall record showed that the majority of students with whom we had sessions came for between 15 minutes and 1 hour per session (63%). The next two clusters were split evenly in to between 1 and 1 hour and 15 minutes per session (16% of students), and greater than 1 hour and 30 minutes per session (16%).

The results for Consistent Students were reassuring, since 82% of the Consistent Students showed up for between 15 minutes and 1 hour per session. This is desirable as session length should be limited and repeated and shorter sessions are generally encouraged.

Inconsistent Students showed an interesting split in session length data. 45% of Inconsistent Students attended sessions at a mean length of greater than 1.5 hours per session, slightly edging out the next cluster of students attending for between greater than 15 minutes and 1 hour per session at 39%. Again, this indicates that many students probably showed up for one or two long sessions in CASAS Prep and did not return. The last cluster was students showing up for greater than 1 hour and 1 hour and 15 minutes per session at 13%.

Instruction by Most Studied Topic

Nearly half of our students came for CASAS Prep (48%). This statistic again supports the hypothesis that a fair chunk of our students came for CASAS Prep only. The next most significant cluster was students receiving help in Fractions, Decimals, and Percentages (39%). This result comports with the results from Part I of the report, delineating the need for extensive remediation in Fractions, Decimals, and Percentages. The last significant cluster was students receiving help in Other. These were topics that did not have a specific alignment to TABE-based categorizations. These topics would have included things such as trigonometry and certain types of algebra.

55% of our Consistent Students worked on Fractions, Decimals, and Percentages the most. This again comports with the results from Part I. The next most studied topic was Other at 27%. This is encouraging because it means that students were willing to work on areas of mathematics outside of the core CASAS and TABE competencies. Lastly was CASAS Prep at 18% of Consistent Students. This means that of the students that came to 5 or more sessions, 18% spent the most time on CASAS Prep. This is encouraging since it means that students were spreading their preparation time over multiple sessions which, as previously noted, this was a practice that was generally encouraged.

62% of Inconsistent Students studied CASAS Prep the most, with the next major cluster being Fractions, Decimals, and Percentages at 32%. This reveals that the majority of our Inconsistent Students showed up for help only with CASAS Prep.

Predominant Mode of Learning

The statistics for Mode of Learning should not be taken as literally as the other statistics cited in this section. The reason for this is that students were not necessarily always grouped into certain learning modes – students may have simply come in when they had time. Therefore, this section serves more as a highlight of what most students *experienced* rather than what they *planned*.

Nearly half of all students experienced One-on-One sessions the most (48%). This is good for the students but potentially bad for the instructor; see the discussion in *Modes of Learning*. The next two most commonly encountered modes of learning were the Small Group (21%) and the Workshop (19%).

46% of Consistent Students experienced One-on-One learning the most, with a nearly identical percentage experiencing the Workshop mode the most (45%). Only 9% of Consistent Students experienced the Small Group mode the most.

Inconsistent Students had a Predominant Mode of Learning breakdown closely resembling that of All Students. 49% of Inconsistent Students experienced the One-on-One mode the most, followed by 26% in Small Group, and 12% with a Learning Partner.

Most Visited Day

39% of All Students came the most on Monday, followed with a near-even split between the next two most attended days of Wednesday (24%) and Thursday (22%). It makes sense that Tuesday was not visited very much because CASAS testing usually took up a great bulk of time on that day.

Consistent Students showed behavior indicating that as the week went on, they were less likely to attend. The three most attended days for the week were Monday (41%), Tuesday (32%), and Wednesday (27%). None of our Consistent Students showed up the most on Thursday.

Inconsistent Students showed different characteristics for attendance. The largest percentage did again attend the most on Monday (38%), followed surprisingly by Thursday (31%). The attendance for Wednesday was comparable to that of Consistent Students at 23%. The explanation for Monday attendance could possibly be explained by those coming for CASAS Prep.

Most Contact-Hour Day

The day with the most contact-hours for all students was Monday at 33%, followed closely by Wednesday at 27%, and Thursday at 24%. It was notable that 16% of All Students received the most Contact-Hours on Tuesday.

The contact-hour profile for Consistent Students was split almost evenly into Monday, Tuesday, and Wednesday at 36%, 32%, and 32% respectively.

The contact-hour profile for Inconsistent Students showed Thursday as the day with the most Contact-Hours at 34%. This was followed very closely by Monday at 32%, and then Wednesday at 25%. Tuesday had the lowest number of maximum contact-hours at 9% of Inconsistent Students. See the "Most Visited Day" section above for a more thorough explanation of this trend.

Most Visited Hours and Days

It was possible for students to have different days for the most sessions and the most hours. For example, a student may have come to a three sessions in a week split over Monday and Tuesday, with two on Monday and one on Tuesday, but the student may have come only for an hour on both Monday sessions and three hours on the Tuesday session. In this case, the most visited day would be Monday but the most contact-hour day would be Tuesday. In general, students were encouraged to set consistent schedules with us as this ensured a consistent pace of work and facilitated the objective measurement of performance.

For our Consistent Students, Monday was the day with the most attended sessions and contact-hours at 46%, followed with an even split between Tuesday and Wednesday at 27% each.

For our Inconsistent Students, Monday and Thursday were the days with the highest percentages, and nearly identical ones at that (34% and 33%). Wednesday was the most visited and contacted day for 25% of Inconsistent Students, and Thursday had only 8% of Inconsistent Students.

Nearly 4 in 10 students had their most hours and their most visited day occur on Monday. The next most visited hour/day combinations were Wednesday and Thursday at 2.5 out of 10 students each.

Most Visited Time Period

Owing to the complexity of students' schedules and variance within our own scheduling in the Math Help Room, we were interested in seeing what the most attended time of day was for our students. Although we tried to have students come at the most convenient times for them, our schedule was not always standardized and thus the statistics in this section should be considered in light of these facts.

The most visited time period for all students was 4 – 5 pm (34%), followed with a split between 3 – 4 pm (17%) and 12 – 1 pm (17%), and lastly 2 – 3 pm (10%). It should be noted that 6 – 7 pm was also a heavily visited time period (9%); this time period was presumably best for those students who worked until 5 pm and then came for CASAS Prep.

For our Consistent Students, the most visited time period was also 4 – 5 pm (64%). This is probably so since this time period was when the Workshops were conducted. The next most visited time period was 3 – 4 pm (18%). This is likely because the same students who wished to come to the workshop also wanted to work on other topics before the workshop began. Lastly was the evenly split time periods of 10 – 11 am (9%) and 12 – 1 pm (9%). The time period between 12 – 1 pm coincided with the opening of the building and thus the Math Help Room.

Inconsistent Students showed interesting time visitation characteristics. While the most visited time period was again 4 – 5 pm (22%), 12 – 1 pm showed nearly equal importance (20%), and three other periods shared nearly equal importance in the most visited time of day, 3 – 4 pm (16%), 2 – 3 pm (14%), and 6 – 7 pm (13%). These statistics indicate that for Inconsistent Students, the time of day they came most was probably in line with the time most convenient for them.

SECTION III

IMPLICATIONS FOR CURRICULUM AND PROGRAM DESIGN USING KEY STUDENT CLUSTERS

METHODS OF REMEDIATION

A Note on Students Presumed to Have Learning Disabilities

An important aspect of serving our students successfully was identifying methods and techniques that were sure to deliver mathematical content effectively. Our suspicion throughout the time we were providing assistance was that a number of students coming to us had learning disabilities. While the on-site protocol was unclear as to whether or not students could receive additional assistance in their classes in the case that they did have a disability, we made sure to spend whatever time necessary with each student to ensure their ongoing mathematical success.

Students were generally not requested to work in a specific mode throughout the period of assistance. That is, the Help Room generally had an open-door policy for incoming students. There were exceptions to this, however, depending on individual student circumstances. We would like to re-iterate the point that students who exhibit characteristics of a learning disability ought to be given means of additional learning assistance and have their predominant mode of learning adjusted accordingly.

Overview

One of the key concerns we had with students is that they were coming to take the CASAS, failing, and then not returning for either a Level-Set or additional CASAS assistance. Attrition due to first-time test takers not passing was significant and motivated us to design pre-CASAS assessments.

Another scenario in which student success was affected was when students made the passing mark on the CASAS, but struggled with the mathematics components of their respective courses. As outlined in Part I of this report, a student may get a passing grade but not actually be at the mathematical competency level required of many of our courses. This is a liability for the student as any further coursework involving mathematics is sure not to get simpler.

Remedies for these two scenarios are discussed here.

Pre-CASAS

Using the information from Part 1 of this report, we are recommending that students be assessed before taking a full-length CASAS. The “pre-CASAS” would consist of five questions drawn from the five most commonly missed CASAS questions and could be administered the day of the CASAS after the information session and before the full-length assessment. Students would be given approximately 15 minutes to answer the questions. Students showing proficiency in the material covered on all five questions would be free to take the full-length CASAS. Students showing any level of deficiency on the pre-CASAS would be required to attend a mathematics session before beginning the full-length assessment that day. The pre-CASAS and math session would add around an hour to the CASAS process.

We realize that this presents another obstacle for students already unsure of their abilities; however, for both the health of the program and the assurance of student success going forward, it is likely that students would benefit by receiving help before undertaking the full-length CASAS.

Key Skills Workshops and Mandated Mathematical Assistance

In addition to the pre-CASAS, it is our recommendation that Key Skills workshops be implemented for the purpose of providing ongoing mathematical assistance to our students. The material covered in these workshops would consist primarily of fundamental mathematical concepts, such as decimals, fractions, percentages, negative number operations, geometry, and basic algebra.

In light of the results presented in Part I, it is also our recommendation that students scoring below a 231 on the CASAS on their first attempt be mandated to receive mathematical assistance for at least a few weeks at the outset of their coursework. This would ensure that students are receiving assistance that will be the foundation of their further mathematical endeavors.

ONGOING PERFORMANCE MONITORING

Overview

Mathematics is a crucial aspect to many of the courses at Shadd. All of the construction courses require a degree of mathematical competency that cannot be assured simply by taking and passing the CASAS. As many of the courses have direct and indirect mathematical components, it is important to implement monitoring systems that will aid in assessing student knowledge of mathematical concepts as they relate to students' respective trades. There are several ways in which student performance metrics could be obtained.

Retrieval of Mathematics Data from Instructors

Instructors are the primary point-of-contact for students once the students have passed the CASAS. As such, the instructors are in the best position to both implement and retrieve mathematical exercises and other material from the students. A number of different metrics could be established by retrieving the exercises and exams from the instructors. Coupling these data with the TABE categories would allow students' ongoing mathematical performance to be measured. Similarly, terminal grades for students' respective courses would allow for a corollary study to be carried out involving variables such as pre-TABE scores, terminal grade, mean test score, etc…

eCASAS

Although the specifics of the paper and electronic versions of the CASAS do not differ materially, the quickness, ease, and reliability of the electronic version suggest that the electronic version is the way to go.

The primary benefit of the eCASAS is the ability to gather large sets of data in a short amount of time. The writing of this report required manually inputting over 200 scores, with a number of answer sheets being marked incorrectly. Thus, to improve reliability of student scores and to enhance ongoing monitoring, it is highly recommended that the eCASAS be implemented.

Mandatory TABE Testing

Although the CASAS provides a baseline assessment of student mathematical competencies, we believe that the TABE is a more accurate reflection of students' mathematical abilities. The reasoning for this is threefold: first, the TABE is a more granular assessment, testing specific mathematical abilities in isolation rather than a conglomerate of abilities as on the CASAS; second, the TABE assess students across a wider and more evenly distributed range of subjects than the CASAS; third, the TABE provides a finer discretization for grade-level equivalencies than the CASAS does.

The TABE was required for all students wishing to receive mathematical assistance from the lab for the reasons just noted and it is our belief that the TABE should be used in conjunction with the CASAS. While the CASAS can be used as an entry assessment, the TABE should be required for students at both the beginning and end of classes.

CONCLUSIONS

Any design of a mathematics assistance program should take into consideration the various modes of learning and how they will affect the student experience. Additionally, the curriculum should be tailored to application-specific settings, such as construction sites.

Scheduling and other administrative procedures should be informed by the data collected in this part of the study. Again, we should able to serve students both at the best times of the week and day. In this way, we will increase the likelihood of student retention.

The implementation of remedial and ongoing performance measures would also increase student retention and enhance the student learning experience.

PART II

Appendices have been omitted from this report for brevity.