**Sierra College IGNITE Final Report**

**A Project Conducted Under the University of West Virginia at Parkersburg**

**National Science Foundation ATE grant award #1003709**

## Project Overview

The Sierra College IGNITE (Infusing GeN-ed Into Technical Education) Project is modeled after the West Virginia University at Parkersburg (WVUP) program, funded through a National Science Foundation ATE grant. The project premise is that, through 'thoughtful and collaborative practices, competencies identified within the general education core courses can be successfully infused into a variety of technical program.'

Sierra College has formed an Interdisciplinary Infusion Team consisting of the Welding Department Chair, the Math Department Chair, and the Director of the Center for Applied Competitive Technologies (CACT), an economic and workforce development initiative funded by the California Community College Chancellor's Office.

The team chose to infuse basic mathematic skills into welding curriculum based on WVUP's pilot of infused mathematics; feedback from regional employers who say that a majority of their skilled employees lack the ability to effectively apply fractions, whole numbers, decimals, adding, subtracting, multiplication, division, in their work; and the high number (89%) of in-coming Sierra College freshman who are not prepared to pursue college-level mathematics.

Referencing Math Competencies identified in WVUP's "Infusion of Math 107 Competencies Into AAS Welding Program," mathematics was infused into two Sierra College Welding courses:

- WT-10 – Exploring Metals/Beginning Welding (Fall 2011), and
- WT-15: Basic Welding Processes (Spring 2012).

Hands on, applied learning methodologies were used to meet student learning styles. A control group and an experimental group for the WT-10 course, and an experimental group for the WT-15 course was used to test the effectiveness of infused curriculum. A pre- and post-test was used to assess mathematics learning outcomes.

Project Team:

Bill Wenzel, Welding Department Chair – bwenzel@sierracollege.edu 916-660-8082

Katie Lucero, Mathematics Department Chair – klucero@sierracollege.edu 916-660-7975

Carol Pepper-Kittredge, Center for Applied Competitive Technologies Director, cpepper-kittredge@sierracollege.edu 916-660-7517

**UWVP IGNITE Questions of Study Applied to the Sierra College IGNITE Project**

1. Will there be a significant difference (p=.05) between the experimental group and the control group in meeting mathematics general competencies as measured by a local-developed math post-test?

2. Will the experimental group perceive a more 'student friendly' program as a result of infusion when compared with the control group as measured by a student questionnaire?

3. Will the experimental group perceive that the infused program meets their academic, skill, professional and personal needs?

**Methodology - Fall 2011 (WT-10)**

Two classes of Welding Technology – 10: Exploring Metals/Beginning Welding – were selected as experimental and control groups. Both classes were taught by the same instructor. The experimental group consisted of 23 students; the control group consisted of 20 students.

Students in both WT-10 classes learned technical skills by fabricating a hibachi barbeque as their culminating project. Technical drawings were produced that included both fractional and decimal measurements. Both classes were provided with drawings and step-by-step instruction on how to fabricate the barbeque, as well as the use of shop equipment and hand tools. The experimental group was given weekly math worksheets designed for additional math review and direct application to the construction of the barbeque. The control group also built the barbeque, but without formal math instruction.

Student learning outcomes for both classes included understanding and advancing skills in:

- Abrasives
- Oxy-acetylene Welding
- Use of the Band Saw
- Brazing
- Use of the Center Punch
- Use of the Leaf Brake
- MSDS
- Neutral Flame
- Use of the Power Punch
- Use of Personal Protective Equipment
- Use of the Twist Drill
- Riveting
- Drill speed RPM
- Tap & Die

For the experimental class, mathematics skills were infused into the curriculum through the direct application in constructing the barbeque and included:

- Addition
- Subtraction
- Whole Numbers
- Fractions
- Multiplication
- Division
- Measurement
- Order of Operation

Pre-tests were developed and administered to both classes on September 6, 2011 and post-tests were administered on December 6, 2011 to assess competencies in these selected basic and pre-algebra math skills.

Infusing Mathematics With Project-Based (Applied) Learning

Eight infused mathematics worksheets were given to the WT-10 morning welding course, while the WT-10 afternoon course did not complete any worksheets. The worksheets were as follows with some notes about their success and adjustments to be made in the future:

WS-1: Measurement

Students practiced measurement skills, reading measurements from a ruler and reducing fractions by placing measurements directly on a ruler and then doing a "grab bag" activity. In the grab bag activity, students reached into a box of various items (e.g. 2" long piece of 3/8" x 4" steel bar), sketched three different objects and then measured the dimensions of the objects to within a sixteenth of an inch.

***Overall this worksheet and activity was a success. This group activity flowed well and students actively participated and grasped the measurement skills well. It was a great ice-breaker for the first day of class.***

WS-2: Handle Construction/Division of Fractions

Students multiplied and divided fractions (dividing whole numbers, fractions and improper fractions) then applied the skill of division by determining how many lengths of a specified measurement could be cut from a rod. The students also had to make conversions between feet and inches. The last two questions lead the students into the construction of their Hibachi Grill Handle and how much material would be used for both the handle and the 9 inch lengths that could be used to construct the grill itself.

***This activity was mostly paper and pencil, but partway through the application questions, the instructor took students into the lab and began the hands-on process of constructing the handle portion of the grill. After completing the lab activity, the students returned to the worksheet and completed it successfully and understood the application. For the students' first time out in the lab, this approach worked well.***

WS-3: Tolerances and Percentage and Squaring

Students found the plus dimension and minus dimension of the tolerance window for a variety of different objects using both fractions and decimals, and percentage applications. In addition, this worksheet included three methods of hands-on squaring applications to square the sides of the grill in the lab assignment.

***This activity was a success for the paper and pencil activity on tolerances and the lab application of squaring. We need to readdress at what stage we apply the percentages component.***

WS-4: Adding and Subtracting Fractions/Decimals

Students worked mathematical problems with no applications to the grill, practicing the skills of adding and subtracting fractions.

***Students struggled with this activity and were not able to complete it during class time. This was the first worksheet that the students took home and returned the following week. Although the work seemed to be done, the impression was that the majority of students did not understand fraction operations of adding and subtracting, and common denominators. We need to add a hands-on group activity to better convey the concept of common denominators.***

WS-5: Vent Hole Layout

Students practiced the skills of order of operations both in relation to how they actually construct their vent hole box and mathematically with fractions. The students had to draw out their vent hole box and place the hole at different fractional measurements within the box, stating the exact fractional measurements around the hole.

***Students struggled with this worksheet and few turned it in completed accurately. We have already adapted the worksheet to include an outline of the objects to assist in laying out the vent hole. As we continue to modify and improve the blueprints of the barbeque, this worksheet will flow more smoothly.***

WS-6: Measurement Exercises

After considering the last worksheet and how the students had struggled, we created a group activity where the students went around the building measuring doors to within ¼" and recorded their findings. The students were also asked to calculate the perimeter and therefore had to practice the skills of measuring and adding fractions to gain perimeter totals. The students were given a challenge of 10 minutes as well as a prize for identifying the smallest and the largest doors based on total perimeter.

***This worksheet was very successful and was an indication that active group work (out in the building measuring doors) is the way to structure our worksheets for maximum success.***

WS-7: Hibachi Grill Construction

Students applied their skills to design on paper two different grill configurations. Then the students had to calculate the amount of material and the cost of material needed to construct each configuration.

***Students had some very unique and creative grill designs but some struggled with how to determine the measurements. We determined it would help to have the grills overlaid on a grid where one box = 1 inch or a scale the students could then use to calculate the amount of material used. Depending on what design a student comes up with (e.g. circles or commercial logos) the grid scale may still prove difficult to calculate total material usage.***

WS-8: Steel Costing

Students practiced skills of adding, subtracting, and multiplying both fractions and decimals with an application to an actual steel delivery invoice. This worksheet included a sample decimal equivalent table for students to use in the future.

***Students were very engaged in this worksheet, and performed above expectations.***

**Results**

Both the infused mathematics and control group were given a pre-test on the first day of class, and a post-test at the end of the semester. The attached graphs include a comparison, question-by-question, of student performance on both tests. It is clear from the results that the infused math group performed significantly better than the control group.

Sixty-seven percent of students in the infused mathematics WT-10 class completed the math worksheets on a regular basis. From the results of the post-test, these worksheets clearly improved the math skills of the infused mathematics group.

The following results were determined from a student survey given at the end of the semester:

- Fifty-two percent of students in the infused mathematics WT-10 class had not enrolled in a math class at Sierra College, but 82 percent said that, as a result of taking this WT-10 class, they would feel more comfortable taking a math class in the future.
- Forty-eight percent of students said that, after taking the infused mathematics WT-10 class, that they would be more likely to assess (or reassess) their math skills for placement in a math class at Sierra College.
- Seventy-one percent of students in the infused mathematics WT-10 class felt that there were more group focused learning opportunities as compared with other courses taken on campus.

We view this first project as a very successful collaboration between a math professor, a welding instructor and a workforce training director. This infused math welding course certainly better prepares student to move through the curriculum and be better prepared for employment. Many of the infused math welding students also feel more math confident.

# Welding: Hibachi Grill Construction

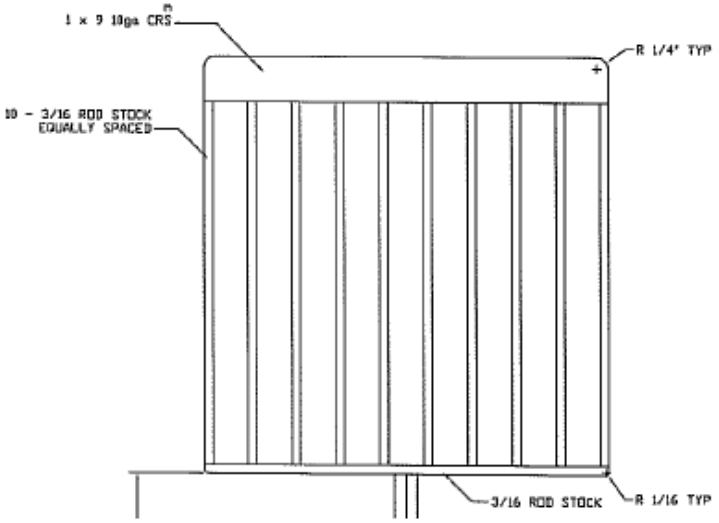
## Fractions and Operations

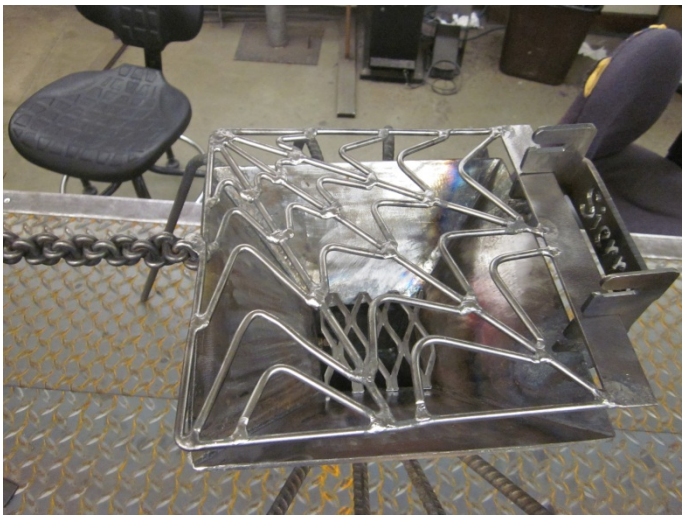
1. Perform the following operations using appropriate order of operations:

| | |
|---|---|
| $\frac{5}{16}+\frac{3}{4}$ | $3+5\left(\frac{3}{8}\right)-\frac{1}{2}$ |
| $2\frac{3}{8}-1\frac{1}{2}$ | $4\left(\frac{1}{8}\right)+\frac{1}{4}\left(3\frac{1}{2}\right)-\frac{3}{4}$ |

2. The standard Hibachi grill will be built using the dimensions given the diagram below. Determine the total length of $\frac{3}{16}$ rod used to construct this grill.

Note: All measurements shown are in inches (in).



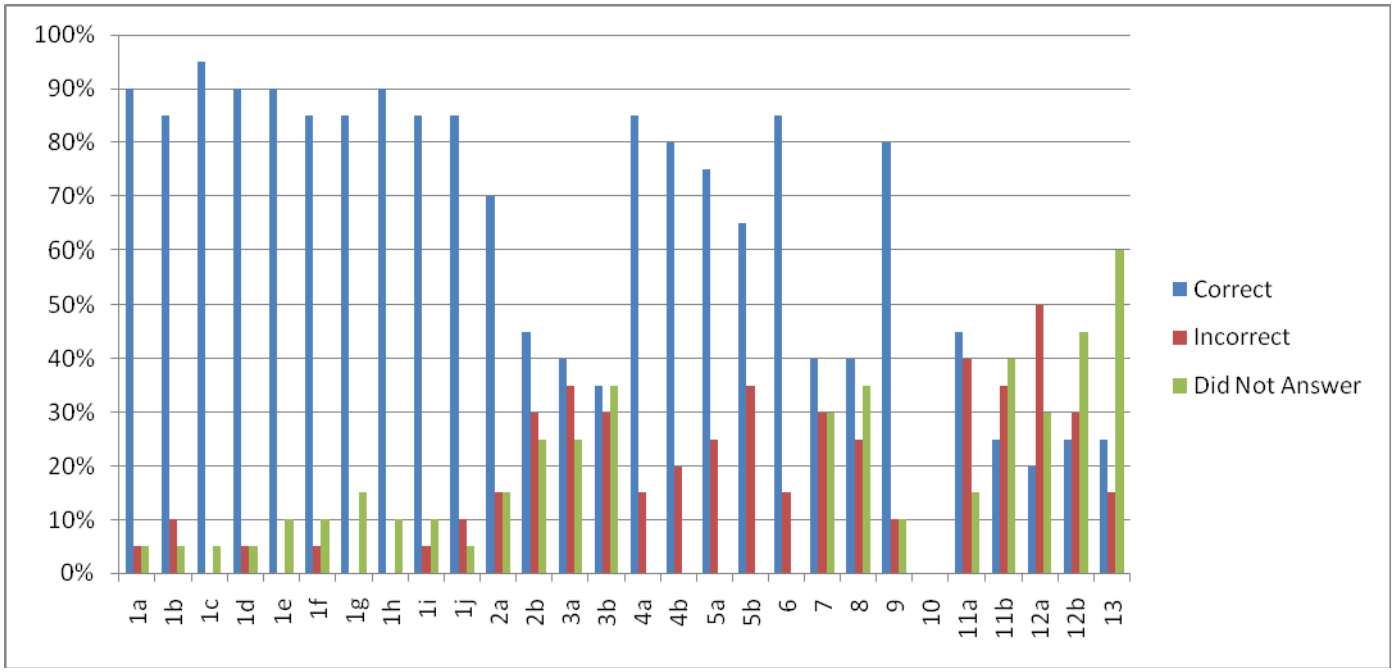



*Worksheet #7 infused math into the design and construction of the grill. Students were then allowed to design and fabricate a custom grill, calculating the total length of 3/16" rod and the total cost of materials as part of their final project.*

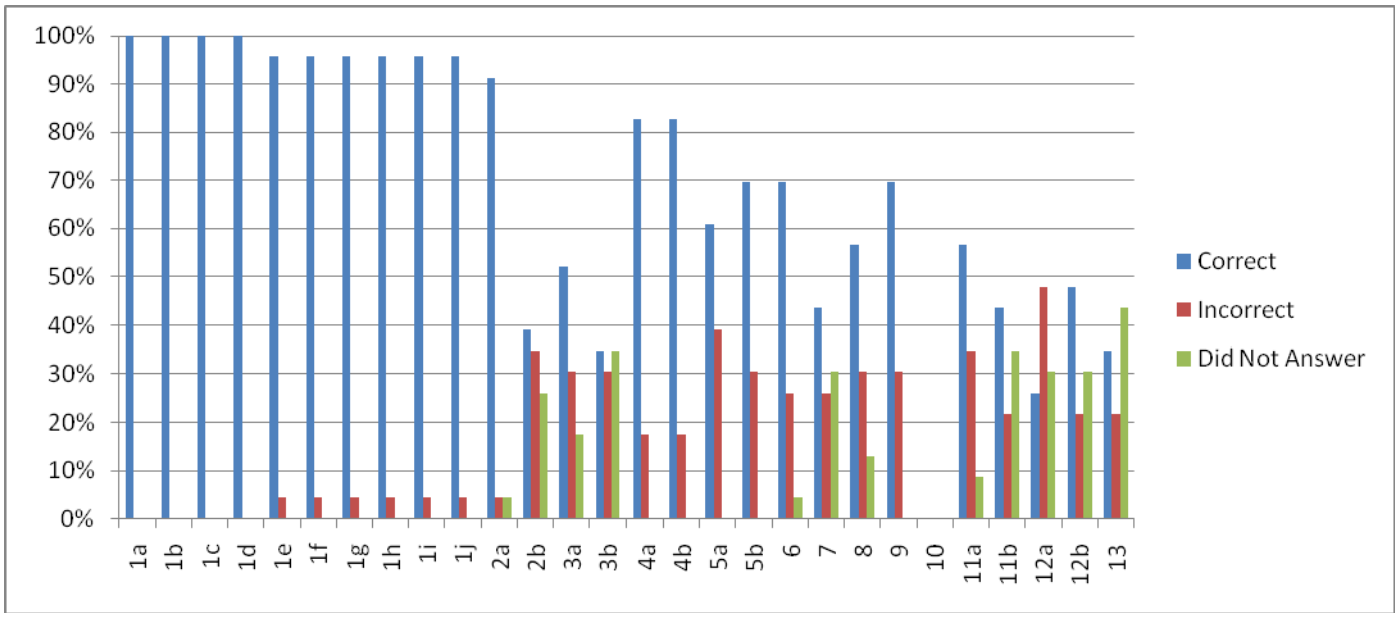
## Improvement by Question: WT-10 Pre- and Post-Test Results

| Question # | Infused Math Group % Improvement | Control Group % Improvement | Question Type |
|---|---|---|---|
| **1a** | 0% | -2% | Measurement |
| **1b** | 0% | -3% | Measurement |
| **1c** | 0% | -7% | Measurement |
| **1d** | 0% | -14% | Measurement |
| **1e** | 4% | -2% | Measurement |
| **1f** | -2% | -38% | Measurement |
| **1g** | 4% | -26% | Measurement |
| **1h** | 4% | -14% | Measurement |
| **1i** | 4% | -20% | Measurement |
| **1j** | 4% | -26% | Measurement |
| **2a** | -24% | -17% | Fraction/Decimal |
| **2b** | 33% | 2% | Fraction/Decimal |
| **3a** | -8% | -22% | Fraction/Decimal |
| **3b** | 32% | -17% | Fraction/Decimal |
| **4a** | 0% | -3% | Decimal |
| **4b** | 6% | -4 | Decimal |
| **5a** | 22% | 7% | Fraction |
| **5b** | 13% | -6% | Fraction |
| **6** | 13% | -9% | Decimal |
| **7** | 18% | -5% | Decimal |
| **8** | 21% | 1% | Fraction |
| **9** | 8% | -59% | Fraction |
| **10** | NA | NA | NA |
| **11a** | 10% | 2% | Order of Operations |
| **11b** | 7% | -7% | Fraction |
| **12a** | 13% | -2% | Geometric Reasoning |
| **12b** | 24% | 4% | Geometric Reasoning |
| **13** | 43% | -7% | Geometric Reasoning |

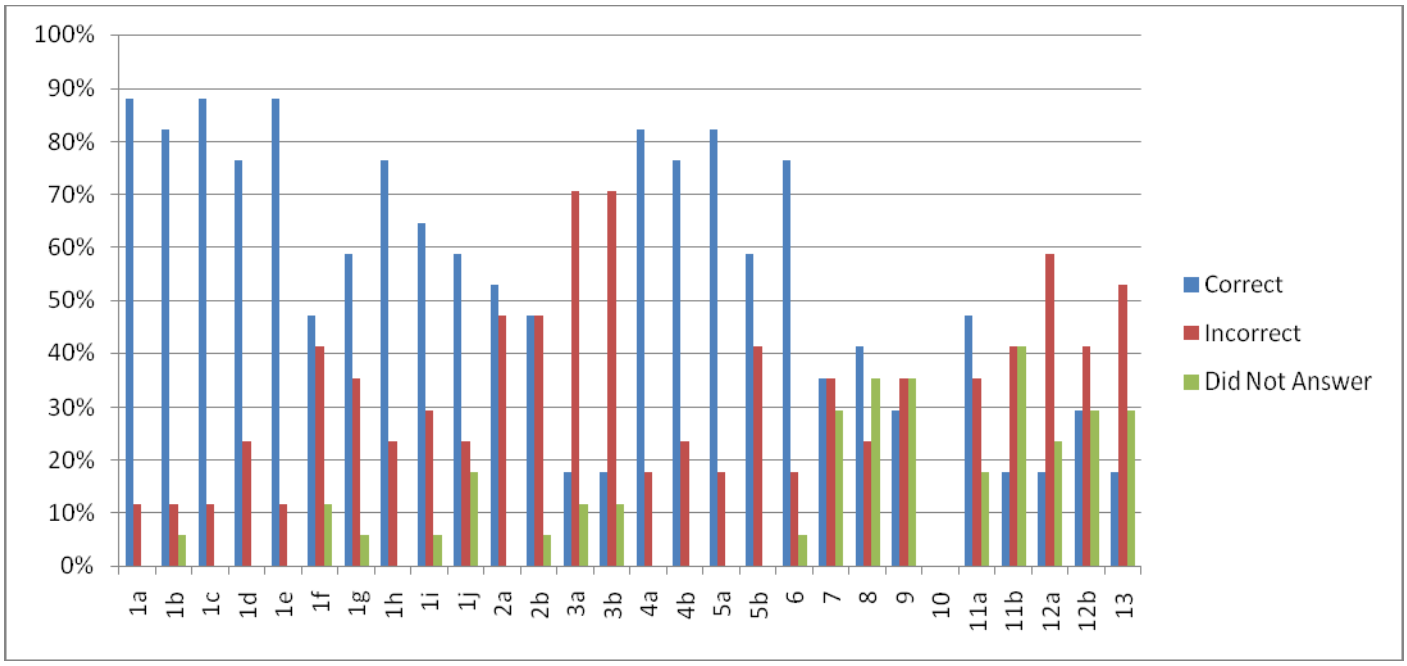
Control WT-10 Group Pre-Test



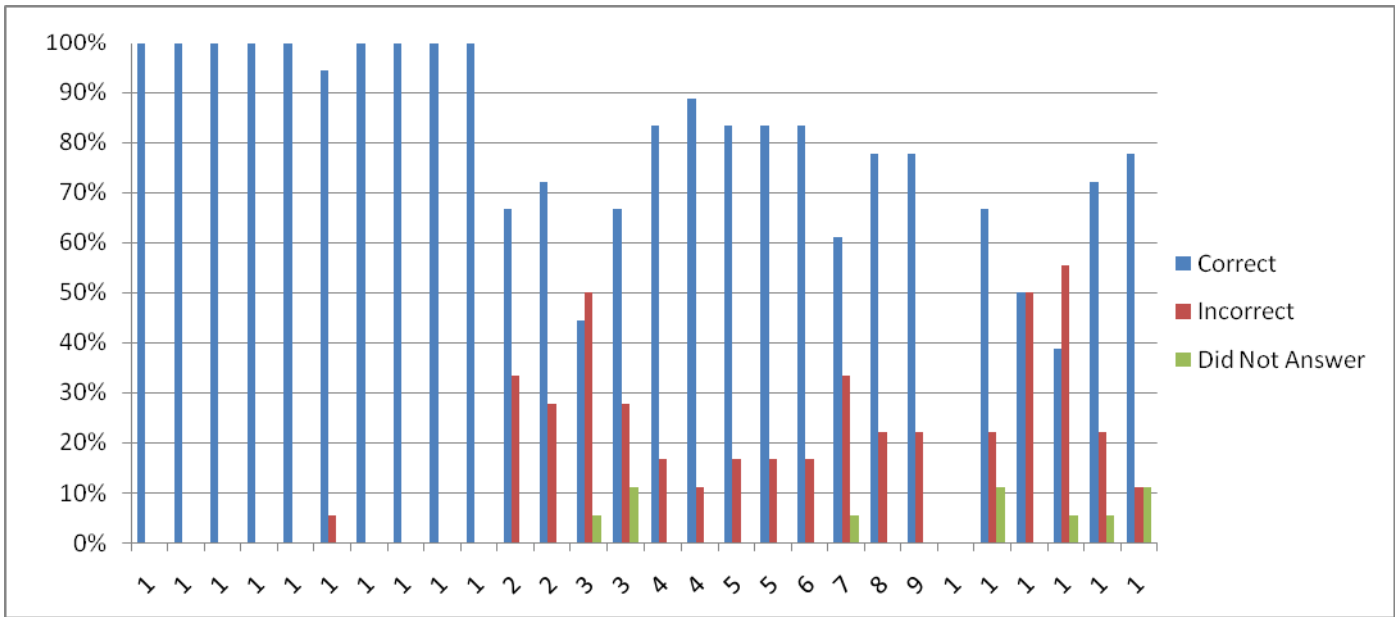

Infused Math WT-10 Group Pre-Test



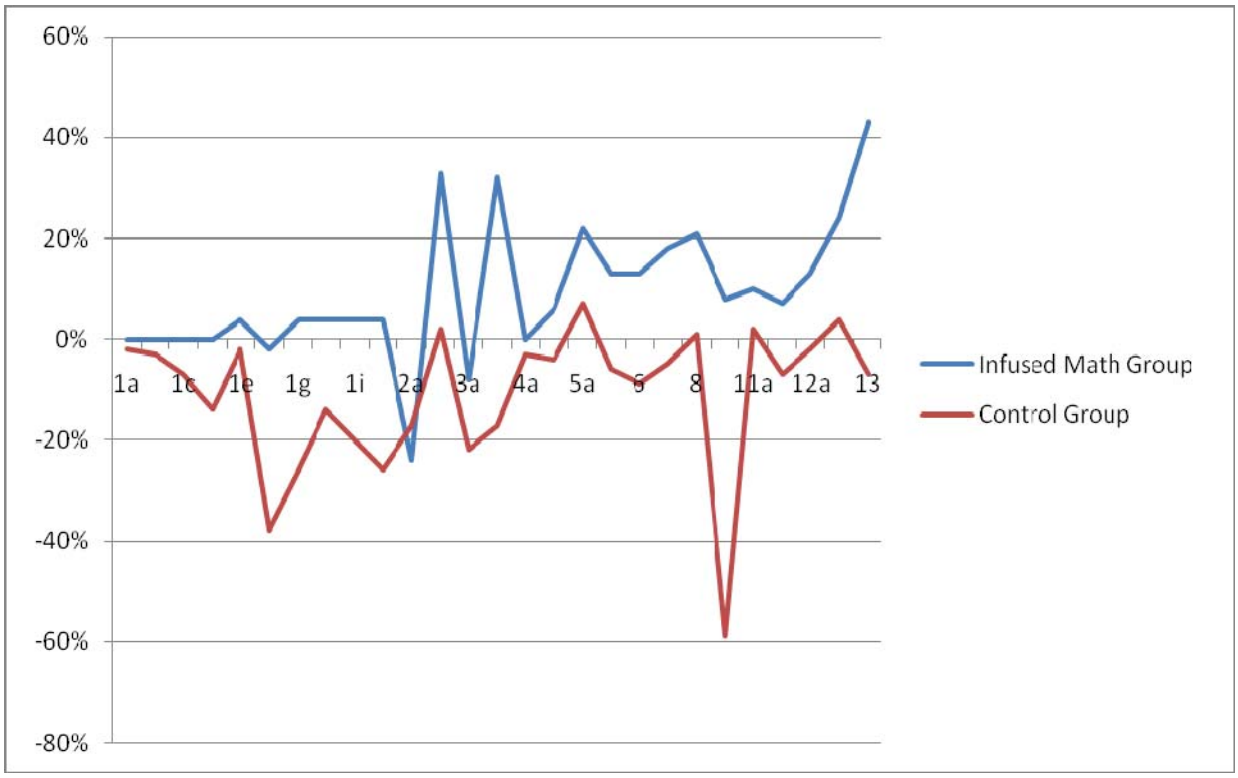
Control WT-10 Group Post-Test




Infused Math WT-10 Group Post-Test



**WT-10 Post-test Comparison: Infused Math & Control Group**



**Methodology - Spring 2012 (WT-15)**

One class of Welding Technology – 15: Welding Fundamentals for Metalworking – was used as an additional course to integrate math into the Welding Program. This was the first semester that this new course was offered. The class consisted of 20 students.

The focus of this course was to introduce students to the three most common electric arc processes. Students in the two-unit course met only once a week for 1 hour of lecture and 3 hours of lab. Students learned technical skills by fabricating a desk lamp as their culminating project; three different electric arc welding processes were taught in the first half of the semester before the students began the project. During the first half of the semester, three weeks were spent on SMAW processes, two weeks on GMAW processes, and two weeks on GTAW processes, providing only 6-8 weeks to complete the desk lamp project.

Due to the fact that this was the first time this project had been incorporated into a course, many of the steps in the fabrication were less established than in the WT-10 class and the construction of the hibachi grill. Technical drawings were not used for this pilot project. Only simplistic shop drawings were provided; most information was conveyed to the students using a whiteboard and lecture. Like the WT-10 course, this course was designed as an exploratory class for students interested in the Welding Program and included instruction on the use of shop equipment and hand tools. Students were asked to complete only two math worksheets. The worksheets were designed to teach surface area, volume, and perimeter.

Student learning outcomes for the class included understanding and advancing skills in:

- Use of Personal Protective Equipment
- Stick Welding (SMAW)
- MIG Welding (GMAW)
- TIG Welding (GTAW)
- Spot Welding (Resistance)
- Use of Foot Shear
- Use of the Band Saw
- Use of the Center Punch
- Use of the Cheek Folder
- Use of the Power Punch
- Use of the Twist Drill
- Understanding Drill speed RPM
- Understanding of Abrasives
- Use of Bending Fixtures

Mathematics skills were infused into the curriculum through the use of the two worksheets and applications to the desk lamp. These included:

- Addition
- Subtraction
- Whole Numbers
- Fractions
- Multiplication
- Division
- Measurement
- Order of Operation
- Perimeter
- Surface Area
- Volume

Pre-tests were developed and administered to the class on February 8, 2012 and post-tests were administered on May 16, 2012 to assess competencies in these selected basic and pre-algebra math skills.

Infusing Mathematics With Project-Based (Applied) Learning

Two infused mathematics worksheets were given to the WT-15 class. The worksheets were as follows with some notes about their success and adjustments to be made in the future:

WS-1: Volume and Surface Area

Students were placed in groups and practiced measurement skills, finding and sketching the dimensions of a hallway. The groups then used these dimensions to answer questions about volume and surface area, such as "What is the total paintable surface area of the hallway excluding doors, windows and lights?" and "What is the total volume of the hallway?"

***Overall this worksheet and activity was a partial success. This group activity could have been conducted before the desk lamp project was started, and it was not as engaging as the 'door game' from the WT-10 class as there was no aspect of competition. Without the time limit and 'reward', students were less interactive and less motivated to complete the activity; however as a whole the activity was completed even if not all students were equally engaged. Students did gain an understanding of applying math in a real world situation outside of the project.***

WS-2: Surface Area and Perimeter

Students completed this worksheet individually, measuring the components of their lampshade and then computing surface area of the three small and three large trapezoidal side panels, and the perimeter of the base of lampshade after the six side panels were welded together.

***Overall this worksheet and activity had mixed success. Students had vastly different mathematical backgrounds ranging from basic math up through calculus. In this WT-15 course, no fraction review was given (as had been given in the WT-10 courses), therefore we saw more varied results. In the future it is clear that the review of fractions and order of operations will be very useful for all groups of students.***

**Results**

The class was given a pre-test during the third week of class, and a post-test at the end of the semester. The attached graphs include a comparison, question-by-question, of student performance on both tests. It is clear from the results, by infusing math, the class performed slightly better on the post-test. Even though there were only two worksheets, the majority of students in the infused mathematics WT-15 class completed the math worksheets.

In retrospect, it would have been a benefit for an earlier start of the math worksheets, especially the Surface Area and Volume worksheet (WS-1), during the initial welding processes training because it didn't relate to the desk lamp project. Also, by adding a fraction review worksheet before the Surface Area and Perimeter worksheet (WS-2) was assigned would likely increase students' comprehension and success.

A future goal would be to have more than two worksheets in a semester course which would better infuse math skills into the hands-on course curriculum.

This continues to be an outstanding example of project collaboration between a math professor, a welding instructor and a workforce training director. Infusing math into welding courses certainly better prepares student to continue through the curriculum and be better prepared for employment. By repetition of math skill sets in multiple welding courses, students' fluency and competency in math will improve, making them more likely to assess into a higher level of mathematics and become more employable.

# Welding: Lampshade Project

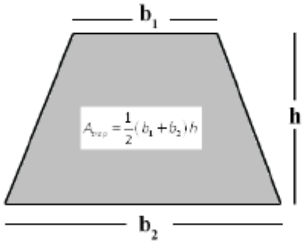
## Surface Area and Perimeter

**Surface Area**: The total area of all the surfaces on the outside of a 3-dimensional object. (i.e. The surface area of an object is the sum of the areas of the individual sides.) Units for surface are squared: $in^2$, $ft^2$, $m^2$, $cm^2$.

**Perimeter**: The length around the outer edge of an object. Units for perimeter are linear as they are a measure of distance/length, $in$, $ft$, $m$, $cm$.

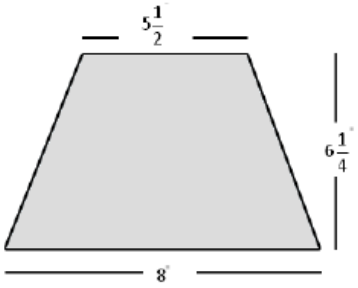
**Area of a Trapezoid**: $A_{trap} = \frac{1}{2}(b_1 + b_2)h$, where

$b_1$ = *length of base 1*
$b_2$ = *length of base 2*
$h$ = *height*




Example (done as a group in class):

Determine the surface area of a one side of a trapezoidal lampshade with the following dimensions:




$$A = \frac{1}{2}\left(8 + 5\frac{1}{2}\right)6\frac{1}{4}$$
$$= \frac{1}{2}\left(\frac{8}{1} + \frac{11}{2}\right)\frac{25}{4}$$
$$= \frac{1}{2}\left(\frac{8}{1}\cdot\frac{2}{2} + \frac{11}{2}\right)\frac{25}{4}$$
$$= \frac{1}{2}\left(\frac{16}{2} + \frac{11}{2}\right)\frac{25}{4}$$
$$= \frac{1}{2}\left(\frac{37}{2}\right)\frac{25}{4}$$
$$= \frac{925}{16}in^2 = 57\frac{13}{16}in^2$$

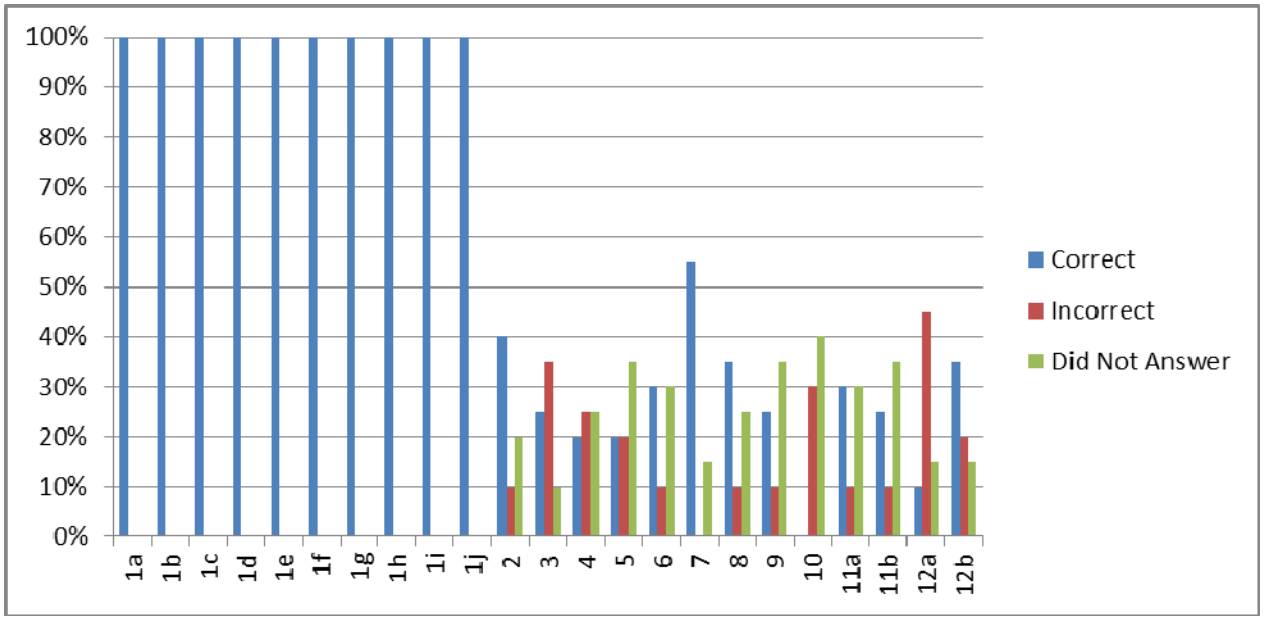


*WT-15 students completed WS-2 focusing on calculating the area and perimeter of the lampshade, and then fabricated the project. Students were encouraged to customize their final design.*

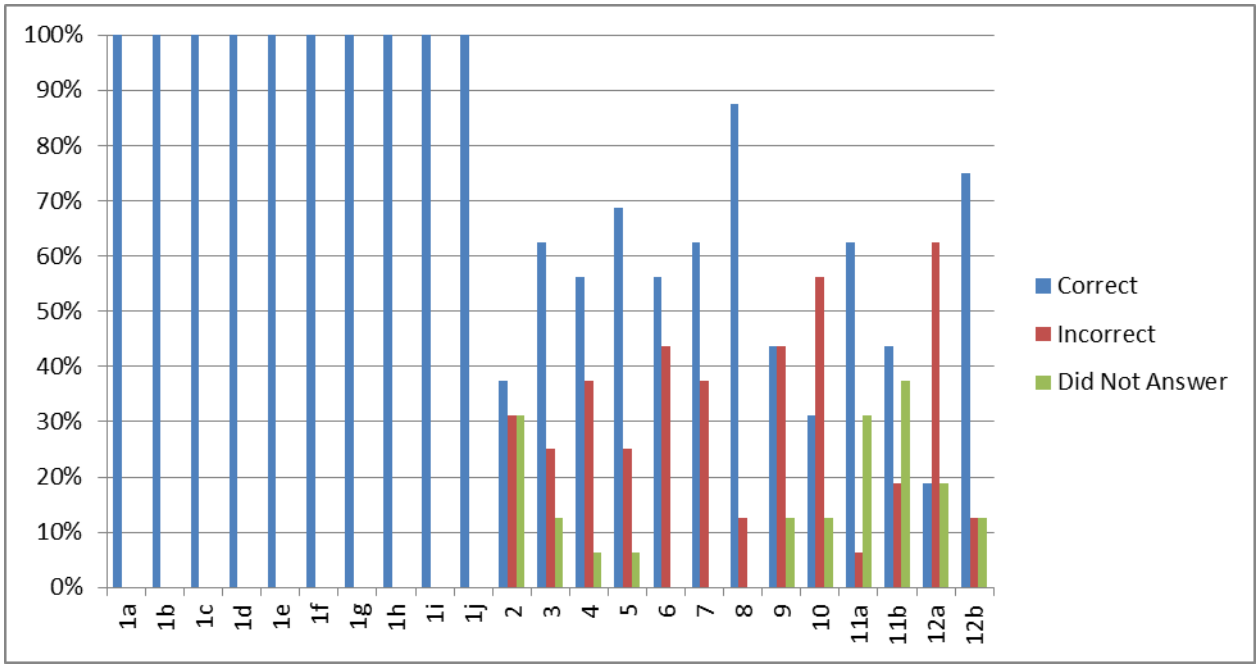
**Improvement by Question: WT-15 Pre- and Post-Test Results**

| Question # | Infused Math Group % Improvement | Question Type |
|---|---|---|
| **1a** | 0% | Measurement |
| **1b** | 0% | Measurement |
| **1c** | 0% | Measurement |
| **1d** | 0% | Measurement |
| **1e** | 0% | Measurement |
| **1f** | 0% | Measurement |
| **1g** | 0% | Measurement |
| **1h** | 0% | Measurement |
| **1i** | 0% | Measurement |
| **1j** | 0% | Measurement |
| **2** | -2% | Fraction |
| **3** | 38% | Fraction |
| **4** | 36% | Fraction |
| **5** | 49% | Fraction |
| **6** | 26% | Order of Operation |
| **7** | 8% | Fraction |
| **8** | 53% | Division |
| **9** | 19% | Algebra |
| **10** | 31% | Algebra |
| **11a** | 33% | Algebra |
| **11b** | 19% | Algebra |
| **12a** | 9% | Algebra |
| **12b** | 40% | Algebra |

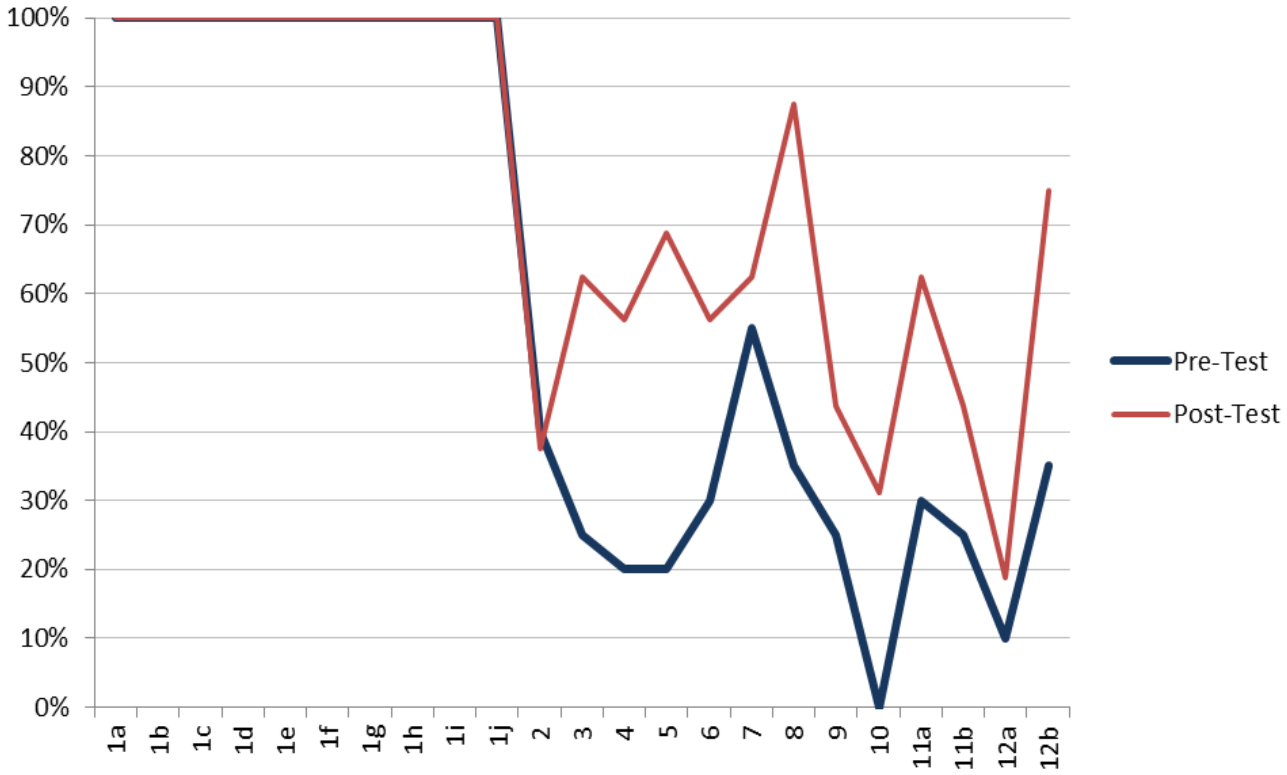
Infused Math WT-15 Group Pre-Test




Infused Math WT-15 Group Post-Test



**WT-15 Post-test Comparison: Infused Math Group**



**Statistical Analysis**

To answer the question on whether there was a significant difference (p=.05) between the experimental group and the control group in meeting mathematics general competencies as measured by a local-developed math post-test, the project asked JD Franz Research, Inc., Sacramento, California, to conduct a statistical analysis of the data. The analysis focused on:

1) **Whether the % improvement for the WT10 Math Infused group between the two tests was large enough to be statistically significant.** The statistician ran two different types of testing to check this: first, a comparison between the number of positive improvements when taken on a question-by-question basis, and second the overall average test score differences.

   **Answer: Yes – in both cases.**

2) **Whether the differences between the WT10 Math Infused group and the Control group were statistically significant.** Again, the statistician ran two different types of testing to check this: Comparing the pre-test scores between the two groups (not statistically different), and comparing the post-test scores between the two groups (statistically significant difference). Then she compared the average % of improvement scores between the two groups (statistically significant).

   **Answer: Yes – when comparing the post-test results.**

3) **Whether the % improvement for the WT15 Math Infused group between the two tests was large enough to be statistically significant.** The statistician ran two different types of testing to check this: first, a comparison between the number of positive improvements when taken on a question-by-question basis, and second the overall average test score differences.

   **Answer: Yes – in both cases.**

# WT10 Math Infused Analysis

Sign Test – used to see if the number of increases and decreases in scores across individual questions created an overall level of statistical significance between the pre-test and the post-test.

## NPar Tests

## Wilcoxon Signed Ranks Test

**Ranks**

| Group | | | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|---|
| Control | Posttest - Pretest | Negative Ranks | 22(a) | 15.59 | 343.00 |
| | | Positive Ranks | 5(b) | 7.00 | 35.00 |
| | | Ties | 0(c) | | |
| | | Total | 27 | | |
| Math Infused | Posttest - Pretest | Negative Ranks | 3(a) | 10.67 | 32.00 |
| | | Positive Ranks | 20(b) | 12.20 | 244.00 |
| | | Ties | 5(c) | | |
| | | Total | 28 | | |

a Posttest < Pretest
b Posttest > Pretest
c Posttest = Pretest

**Test Statistics(c)**

| Group | | Posttest - Pretest |
|---|---|---|
| Control | Z | -3.701(a) |
| | Asymp. Sig. (2-tailed) | .000 |
| Math Infused | Z | -3.228(b) |
| | Asymp. Sig. (2-tailed) | .001 |

a Based on positive ranks.
b Based on negative ranks.
c Wilcoxon Signed Ranks Test

Paired Samples T- Test – used to see if the overall average test scores showed statistically significant differences between the pre-test and the post-test.

## Paired Samples T-Test

**Paired Samples Statistics**

| Group | | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|---|
| Control | Pair 1 | Pretest | .6519 | 27 | .25701 | .04946 |
| | | Posttest | .5468 | 27 | .25265 | .04862 |
| Math Infused | Pair 1 | Pretest | .6910 | 28 | .28036 | .05298 |
| | | Posttest | .7817 | 28 | .23664 | .04472 |

**Paired Samples Correlations**

| Group | | | N | Correlation | Sig. |
|---|---|---|---|---|---|
| Control | Pair 1 | Pretest & Posttest | 27 | .862 | .000 |
| Math Infused | Pair 1 | Pretest & Posttest | 28 | .873 | .000 |

**Paired Samples Test**

| | | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | 95% Confidence Interval of the Difference | | | | |
| Group | | | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | | | |
| Control | Pair 1 | Pretest - Posttest | .10501 | .13402 | .02579 | .05199 | .15803 | 4.071 | 26 | .000 |
| Math Infused | Pair 1 | Pretest - Posttest | -.09075 | .13710 | .02591 | -.14392 | -.03759 | -3.503 | 27 | .002 |

# WT10 Math Infused versus WT10 Control Group Analysis

Independent Samples T- Test – used to see if the overall average test scores showed statistically significant differences *between the two groups* for the pre-test scores and for the post-test scores.

## Independent Samples T-Test

**Group Statistics**

| | Group | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pretest | Control | 27 | .6519 | .25701 | .04946 |
| | Math Infused | 28 | .6910 | .28036 | .05298 |
| Posttest | Control | 28 | .5273 | .26860 | .05076 |
| | Math Infused | 28 | .7817 | .23664 | .04472 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | 95% Confidence Interval of the Difference | |
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | Lower | Upper |
| Pretest | Equal variances assumed | .046 | .832 | -.539 | 53 | .592 | -.03914 | .07260 | -.18476 | .10647 |
| | Equal variances not assumed | | | -.540 | 52.869 | .591 | -.03914 | .07248 | -.18453 | .10625 |
| Posttest | Equal variances assumed | 1.995 | .164 | -3.761 | 54 | .000 | -.25444 | .06765 | -.39007 | -.11880 |
| | Equal variances not assumed | | | -3.761 | 53.156 | .000 | -.25444 | .06765 | -.39012 | -.11876 |

Independent Samples T- Test – used to see if the average % of improvement from pre-test to post-test showed statistically significant differences *between the two groups*.

## Independent Samples T-Test

**Group Statistics**

| | Group | N | Mean | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| % Improvement | Control | 27 | -.1089 | .14329 | .02758 |
| | Math Infused | 27 | .0922 | .13827 | .02661 |

**Independent Samples Test**

| | | Levene's Test for Equality of Variances | | t-test for Equality of Means | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | F | Sig. | t | df | Sig. (2-tailed) | Mean Difference | Std. Error Difference | 95% Confidence Interval of the Difference | |
| | | | | | | | | | Lower | Upper |
| % Improvement | Equal variances assumed | .011 | .916 | -5.248 | 52 | .000 | -.20111 | .03832 | -.27801 | -.12421 |
| | Equal variances not assumed | | | -5.248 | 51.934 | .000 | -.20111 | .03832 | -.27801 | -.12421 |

# WT15 Math Infused Analysis

Sign Test – used to see if the number of increases and decreases in scores across individual questions created an overall level of statistical significance between the pre-test and the post-test.

## NPar Tests

## Wilcoxon Signed Ranks Test

**Ranks**

| WT15 Math Infused | | N | Mean Rank | Sum of Ranks |
|---|---|---|---|---|
| Posttest - Pretest | Negative Ranks | 1(a) | 1.00 | 1.00 |
| | Positive Ranks | 12(b) | 7.50 | 90.00 |
| | Ties | 10(c) | | |
| | Total | 23 | | |

a Posttest < Pretest
b Posttest > Pretest
c Posttest = Pretest

**Test Statistics(b)**

| WT15 Math Infused | Posttest - Pretest |
|---|---|
| Z | -3.111(a) |
| Asymp. Sig. (2-tailed) | .002 |

a Based on negative ranks.
b Wilcoxon Signed Ranks Test

Paired Samples T- Test – used to see if the overall average test scores showed statistically significant differences between the pre-test and the post-test.

## Paired Samples T-Test

**Paired Samples Statistics**

| WT15 Math Infused | | Mean | N | Std. Deviation | Std. Error Mean |
|---|---|---|---|---|---|
| Pair 1 | Pretest | .5870 | 23 | .38383 | .08003 |
| | Posttest | .7418 | 23 | .27001 | .05630 |

**Paired Samples Correlations**

| WT15 Math Infused | | N | Correlation | Sig. |
|---|---|---|---|---|
| Pair 1 | Pretest & Posttest | 23 | .898 | .000 |

**Paired Samples Test**

| | | Paired Differences | | | | | t | df | Sig. (2-tailed) |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | 95% Confidence Interval of the Difference | | | | |
| WT15 Math Infused | | Mean | Std. Deviation | Std. Error Mean | Lower | Upper | | | |
| Pair 1 | Pretest - Posttest | -.15489 | .18463 | .03850 | -.23473 | -.07505 | -4.023 | 22 | .001 |

# Appendix

WT-10 Pre-Test

WT-10 Post-Test

WT-10 Worksheets 1- 8

WT-10 Student Survey Results

WT-10 Hibachi Technical Drawings

WT-15 Pre-Test

WT-15 Post-Test

WT-15 Worksheets 1 & 2

WT-15 Student Survey Results