Promoting Student Engagement in Science, Technology, Engineering, the Arts and Mathematics:

An Evaluation of the Salvadori Center's *STEAM* Enrichment Program in Scranton and Riverside Schools

Evaluation Report

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Executive Summary

This report includes findings from YSI's evaluation of the Salvadori Center's Bridges program as implemented during the 2017-18 school year to approximately 900 7th grade students attending public schools in Scranton and Riverside, Pennsylvania. The *Bridges* program is an 8-week module designed for in-school STEM residencies. Throughout the program, students investigate different types of bridges and their functions, while learning about the history of some of the world's most prominent bridges. Students are also able to identify the structural parts that make up different types of bridges and understand the forces that enable each bridge to support a load.

During the 2017-18 school year, Youth Studies, Inc. administered pre- and post-assessments to students participating in *Bridges* at four schools in the Scranton and Riverside school districts: Northeast Scranton Intermediate, South Scranton Intermediate, West Scranton Intermediate, and Riverside JSHS. A total of 1,481 assessments were conducted with 881 participating students. The following are key highlights from YSI's evaluation of the *Bridges* initiative:

- A total of 881 students participated in YSI's assessment of the *Bridges* program. Forty-nine (49) percent of participating students were female. Forty-seven (47) percent of surveyed students self-identified as "Black or African American," "Hispanic/Latino," or multiracial. Four percent of students self-identified as "Asian."
- The evaluation results reported below include evidence that the *Bridges* program supports several national math and science learning standards, including:
    - Common Core Math CCSS.MATH.CONTENT.HSG.MG.A.3. Apply geometric methods to solve design problems (e.g., designing an object or structure to satisfy physical constraints or minimize cost; working with typographic grid systems based on ratios).
    - CCSS.MATH.CONTENT.3.MD.B.4: Generate measurement data by measuring lengths using rulers marked with halves and fourths of an inch.
    - Next Generation Science learning standard MS-PS2-1. Apply Newton's Third Law to design a solution to a problem involving the motion of two colliding objects.
- *Bridges* participants at both Scranton and Riverside public schools demonstrated a statistically significant increase in their understanding of various types of bridges, and the advantages and features of different bridge designs (See Page 8). Assessment results found that Scranton students improved their knowledge by **46** percent. Riverside students demonstrated an improvement of **51** percent. Both findings were found to be statistically significant.
- *Bridges* participants at both Scranton and Riverside public schools demonstrated a statistically significant increase in their understanding of the effects of common forces on

moving objects (See Page 10). Participating Scranton students demonstrated a **9** percent improvement in their knowledge of common forces and Riverside students demonstrated an improvement of **15** percent. Both results were found to be statistically significant.

- *Bridges* participants at both Scranton and Riverside public schools demonstrated a statistically significant improvement in their ability to interpret chronological timeline data (See Page 14). Participating students at both Scranton and Riverside schools demonstrated a **13** percent improvement in their timeline skills. Both results were found to be statistically significant.
- *Bridges* participants demonstrated a significant increase in their confidence that they can be successful in math and science as measured by the Fennema-Sherman Attitudes Scale, a math and science attitude scale that has been used extensively in education research (See Page 16).
- *Bridges* participants demonstrated a significant increase in their motivation to pursue educational and career choices in science as measured by the assessment items from the Programme for International Student Assessment (PISA) (See Page 17).

Background

A challenge facing many educational institutions, especially those in urban settings serving culturally and linguistically diverse populations, is the disconnect that often exists between schools and students' home communities. Science education researchers have argued that this disconnect between school and home/community life may result in students feeling that science is impractical, alien, and in contradiction with the beliefs and practices of their lives (Basu & Barton, 2007). Urban and low-income students, in particular, are more likely to hold negative sentiments about science, such as boredom, anxiety, confusion, and frustration. Bouillion and Gomez (2001) have argued that this decoupling leads to a disengagement in which some learners fail to see schooling as an avenue for life progress. With respect to science education, this phenomenon jeopardizes our nation's goal to become first in the world in science achievement among students (U.S. Department of Education, 1991).

In response to this challenge, many are advocating an instructional approach that emphasizes hands on activities and learning by doing. In fact, many of the recent national reports on the conditions of science teaching and learning in schools call for, "More active learning for students and less passivity; more hands-on, direct opportunities to 'make meaning'" (Schmieder & Michael-Dyer, 1991). To that end, science education standards set forth by the American Association for the Advancement of Science and the National Research Council now urge less emphasis on memorizing decontextualized scientific facts and more emphasis on students investigating the everyday world and developing deep understanding from their inquiries (Marx et al., 2004). These approaches to instruction challenge educators to transform students' experiences in science classrooms. For teachers who are used to using instructional methods based on recitation and direct instruction, inquiry teaching challenges them to develop new content knowledge and pedagogical techniques (Basu & Barton, 2007; Bouillion & Gomez, 2001).

This report includes recent (2017-18) findings from YSI's evaluation of the Salvadori Center's second year implementing an 8-week STEAM enrichment program in the Scranton and Riverside school districts in Northeastern Pennsylvania. STEAM is an educational approach to learning that uses Science, Technology, Engineering, the Arts and Mathematics as access points for guiding student inquiry, dialogue, and critical thinking. The Salvadori Center's program aims to engage students in math and science using a hands-on, project-based approach. The Salvadori Center is a not-for-profit educational organization that uses the principles of architecture and engineering to help students in schools and out-of-school time programs to master mathematics and science concepts. During the 2017-18 school year, the Salvadori Center implemented the *Bridges* program, which uses investigations of the built environment to introduce and reinforce STEAM concepts and skills. The *Bridges* program uses hands-on activities and design challenges to foster student learning and exploration of various topics relating to the history, design, and construction of bridges. Throughout the module, students investigate the different types of bridges and their functions, while learning about the history of some of the world's most prominent bridges. Students are also able to identify the structural parts that make up different types of bridges and understand the forces that enable different bridge types to support a load.

This evaluation is being implemented by Youth Studies, Inc. (YSI), an evaluation firm that provides research and program evaluation services to a variety of youth-serving organizations, including schools and community-based youth programs.

This curriculum is aligned to the Common Core Math Standards and the New York State Standards for Math, Science, and Technology. Each lesson uses a collaborative, hands-on, project-based approach. Activities in the earlier sessions focus on developing students' skills of measurement, observation, classification, and drawing conclusions based on the results of a controlled experiment. In later sessions, students explore a real-world application of the collaborative processes used in project development and construction by designing a scaled prototype of a model bridge under a given set of constraints. Students analyze and interpret the relative strength of different truss bridge designs by testing their load-bearing capacities and using these findings to modify their design and build an improved version of their model.

Description of Evaluation Process

Participant Assessments

YSI developed pre- and post-participation student assessments that were administered by Salvadori instructors during the first and final *Bridges* sessions, at participating schools. In addition to basic background questions (e.g. gender, age, and ethnicity), the pre- and post-assessments included standardized measures of: 1) students' familiarity with various types of bridges and their relative benefits; 2) students' understanding of the effects of common forces on objects; 3) students' ability to read and interpret a chronological timeline; 4) students' understanding of the scientific inquiry process; 5) students' confidence in their ability to succeed in math and science; and 6) students' future-oriented motivation to pursue math and science careers.

A total of 1,481 assessments were completed and analyzed by YSI. Of those 1,481 assessments, 735 were pre-test, or baseline assessments administered at the launch of the program, and 746 were post-test assessments. Table 1 below includes a breakdown of the number of assessments conducted at each of the participating schools:

Table 1. Participant's School

Grade	# of Assessments
Northeast Scranton Intermediate	519
West Scranton Intermediate	713
Riverside JSHS	249
Total	*1,481*

YSI was able to match pre-test and post-test assessments for a total of 600 out of 881 students (68%). The remaining 281 students participated in the pre-test only (135) or only submitted a post-test assessment (146).

As seen in Table 2, 49 percent of students assessed were female. Moreover, 45 percent of participating students self-identified as "White", 20 percent as "Hispanic/Latino", 8 percent as "Black or African American", and 4 percent as "Asian." An additional 4 percent of respondents self-identified as "Other Race," and 19 percent of respondents selected more than 1 racial category.

Table 2. Background Characteristics of BRIDGES Participants

Demographic Characteristics	% of Students
Gender	
Male	51
Female	49
Ethnicity	
Black or African-American	8
Hispanic/Latino (of any race)	20
White	44
American Indian or Alaska native	1
Asian	4
Other	4
Multiracial	19

Note: Percentage totals may not equal 100 due to rounding.

To assess how Bridges participants' attitudes about math and science may have changed over the course of the program, YSI evaluators included survey items from the Fennema-Sherman Attitudes Scale, a math and science attitude scale that has been used extensively in education research. Using students' responses to questions from the Fennema-Sherman Attitudes scale, we constructed measures of students' personal *confidence* in their ability to perform well in math and science. These attitudes were assessed prior to and after students participated in the *Bridges* program. More specifically, students were asked in both pre- and post-test surveys to agree or disagree with the following statements related to these attitudes. Students' responses to similar statements were averaged to form measures of students' confidence in math and science.

Table 3. Modified Fennema-Sherman Attitude Scales

Confidence Items
Math is hard for me
Science is hard for me
I know I can do well in math
I know I can do well in science

I am sure I can learn math
I am sure I can learn science
I think I could do advanced math and science

Three survey items from the Programme for International Student Assessment (PISA) were included to assess students' future-oriented motivation to pursue science education and careers (OECD, 2007). Those items are listed in Table 4.

Table 4. PISA Future-Oriented Science Motivation Scale

Future-Orientated Science Motivation
I would like to work in a career involving science.
I would like to study science when I go to college.
I would like to work on science projects as an adult.

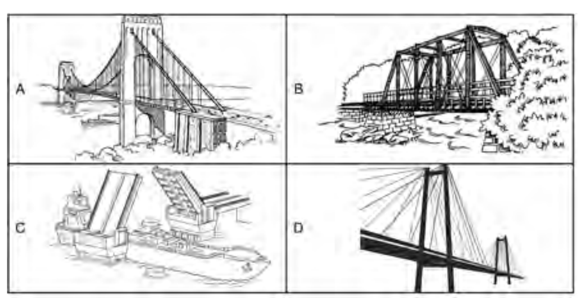
Participant Outcome Findings

Bridges participants were surveyed at the beginning and conclusion of the 8-week program cycle during the 2017-18 school year. In addition to basic background questions (e.g. gender, age, and ethnicity), the pre- and post-assessments included standardized measures of: 1) students' familiarity with various types of bridges and their relative benefits; 2) students' understanding of the effects of common forces on objects; 3) students' ability to read and interpret a chronological timeline; 4) students' understanding of the scientific inquiry process; 5) students' confidence in their ability to succeed in math and science; and 6) students' future-oriented motivation to pursue math and science careers.

Students' Familiarity with Various Bridge Types

The pre- and post-test questionnaires included a performance task designed to assess students' familiarity with different types of bridges, and the advantages and features of different bridge designs. The specific items included the following:

Table 5. Bridge Type Assessment Items

Question #	Assessment Item
24	Match the following types of bridges with the correct name. ***Bridge Type*** Suspension Bridge Draw Bridge Truss Bridge Cable-Stayed Fan Bridge 

YSI created an overall measure of student comprehension that summarizes how well students performed on these tasks. Possible values for this measure ranged from 0 (indicating 0 correct responses) to 100 (indicating that the students answered all questions correctly).

As seen in Table 6 below, *Bridges* participants demonstrated a significant increase in their recognition and understanding of different types of bridges and their benefits at both participating Scranton and Riverside schools. A paired-samples t-test was conducted to compare students' knowledge of bridge types and functions at the beginning of the *Bridges* program and after the module was completed.

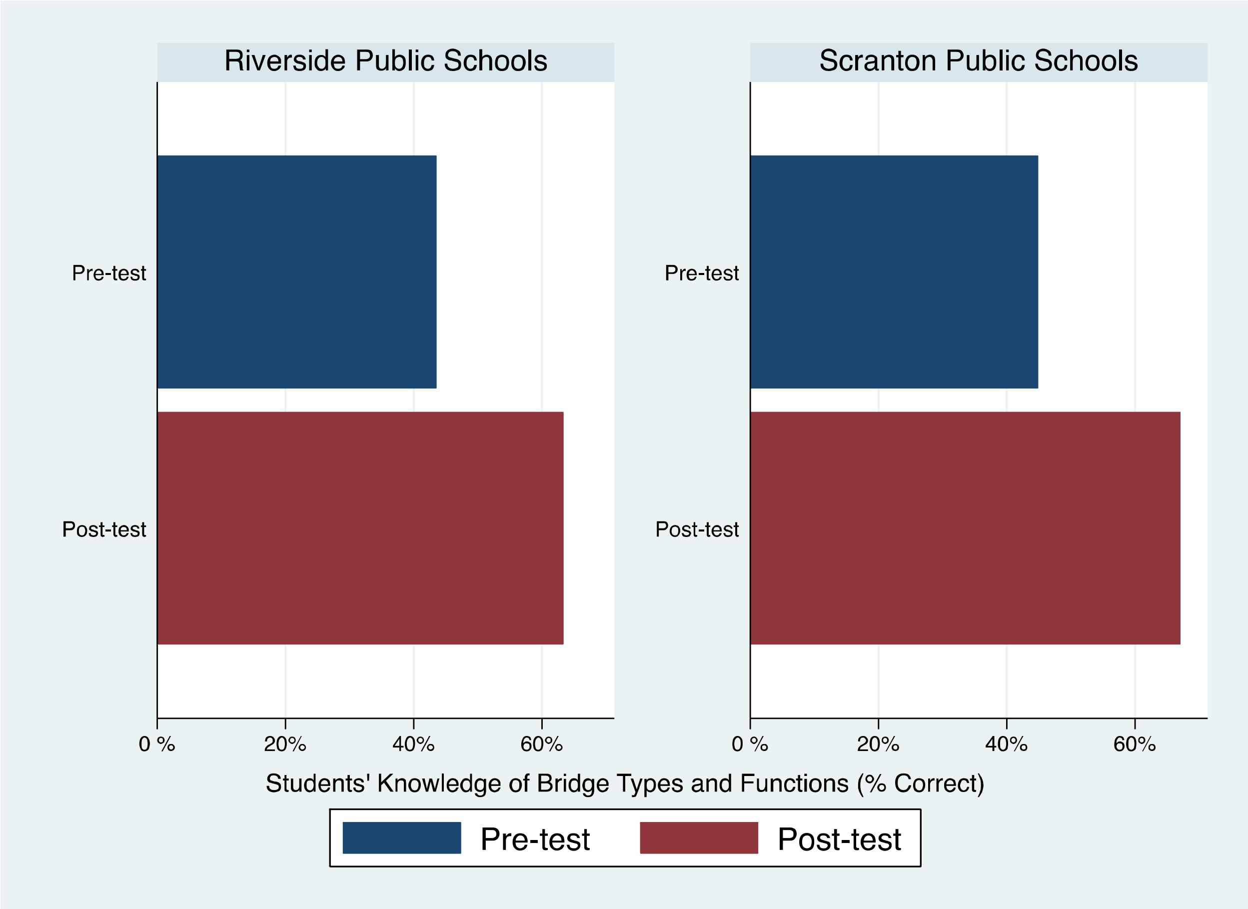
There were significant improvements in measured pre-test vs. post-test knowledge observed for students participating in both Riverside and Scranton public schools. At the participating Scranton schools, the mean pre-test score was 46% (M=45.6, SD=27.0). After 8 weeks of the program, Scranton students scored an average of 67% (M=66.8, SD=29.7) on the post-test assessment. This represents an average improvement of 21% observed over the course of the 8 week intervention ($M_{difference}$=21.2, SD=33.5); t (482)=13.9, p < .0001. At the Riverside JSHS, the mean pre-test score for participating 7th grade students was 43% (M=42.6, SD=29.3). After 8 weeks of the program, Riverside students scored an average of 64% (M=64.4, SD=32.2) on the post-test assessment. This represents an average improvement of 22% observed over the course of the 8 week intervention ($M_{difference}$=21.9, SD=38.0); t (116)=6.2, p < .0001. These findings represent a 46%improvement from pre- to post-test for Scranton public school students and a 51%improvement for Riverside students. Figure 1 below presents a visual representation of the pre-test vs. post-test comparison for both participating Scranton and Riverside students.

Table 6. Pre- vs. Post-test Assessments of Students' Familiarity with Bridge Types and Functions

	Student Knowledge of Bridges Mean (range 0-100)		
	Pre-test Score	Post-test Score	Change
Northeast Scranton Intermediate	40.6	61.1	**+ 20.4**[#]
West Scranton Intermediate	49.9	71.8	**+ 21.9**[#]
Riverside JSHS	42.6	64.4	**+ 21.9**[#]
All Schools	*45.0*	*66.3*	***+ 21.3***[#]

[#] Statistically significant change from baseline to follow-up (p<.0001)

Figure 1. Pre- vs. Post-test Assessments of Students' Knowledge of Bridge Types and Functions

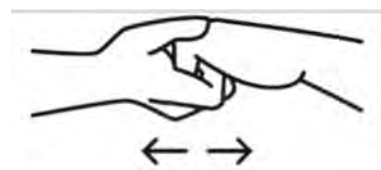
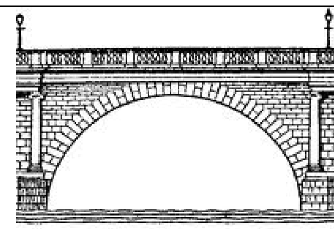
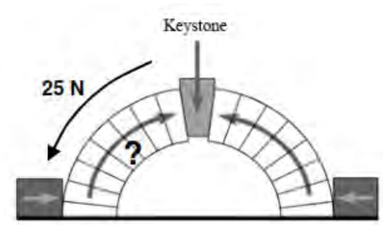


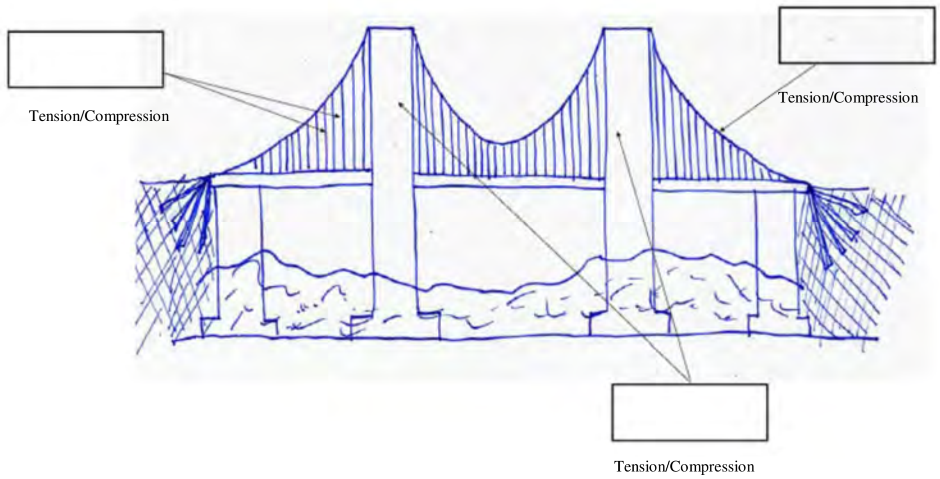
<u>Students' Understanding of the Effects of Common Forces on Objects</u>

The pre- and post-test student questionnaires included several items to assess students' understanding of the effects of common forces on moving objects. More specifically, these items required students to distinguish between the forces of tension and compression and to interpret Newton's Third Law of Motion. These concepts are central to the *Bridges* curriculum.

The specific assessment items included the following:

Table 7. Common Forces Assessment Items

Question #	Assessment Item
25	Label which force is being used in each picture below. ☐ Tension ☐ Compression  
26	When all other things are equal, which of the following is true about a beam bridge? ❑ The shorter the main span, the stronger the beam bridge. ❑ The longer the main span, the stronger the beam bridge.
29	If a truck weighing 500 pounds crosses this bridge, how will the weight of the truck be distributed? Fill in the blanks below: ____ pounds will be distributed to the right side of the arch and____ pounds will be distributed to the left side of the arch. 
30	Newton's Third Law states that for every action there is an equal and ____________ reaction. ❑ opposite ❑ perfect ❑ stable ❑ positive
31	If a pile of snow pushes down on the keystone of an arch bridge so that 25N are distributed to the left side of the bridge, how much force will the ground "push back" with on that side of the bridge? ___________Newtons 

32	Label each box in the diagram below to show which force is applied on that part of the bridge: TENSION or COMPRESSION. 

YSI created an overall measure of student comprehension of common forces that summarizes how well students performed on the assessment items listed above. Possible values for this measure ranged from 0 (indicating 0 correct responses) to 100 (indicating that the students answered all questions correctly).

A paired-samples t-test was conducted to compare students' knowledge at the beginning and conclusion of the *Bridges* program. As seen in Table 8 below, *Bridges* participants demonstrated a significant increase in their ability to recognize and analyze the effects of common forces on objects at both Scranton and Riverside schools. At the participating Scranton schools, the mean pre-test score was 59% (M=59.1, SD=26.9). After 8 weeks of the program, Scranton students scored an average of 64% (M=64.3, SD=27.1) on the post-test assessment. This represents an average improvement of 5% observed over the course of the 8 week intervention ($M_{difference}$=5.3, SD=29.7); t (482)=3.9, p < .0001. At the Riverside JSHS, the mean pre-test score for participating 7th grade students was 59% (M=59.4, SD=28.6). After 8 weeks of the program, Riverside students scored an average of 68.6% (M=68.6, SD=30.8) on the post-test assessment. This represents an average improvement of 9% observed over the course of the 8 week intervention ($M_{difference}$=9.0, SD=33.4); t (116)=2.9, p < .0001. **These findings represent a 9 percent improvement from pre- to post-test for Scranton public school students and a 15 percent improvement for Riverside students. Figure 1 below presents a visual representation of the pre-test vs. post-test comparison for both participating Scranton and Riverside students.** Figure 2 below presents a visual representation of the pre-test vs. post-test comparison for both participating Scranton and Riverside students.

Table 8. Pre- vs. Post-test Assessments of Students' Understanding of the Effects of Common Forces

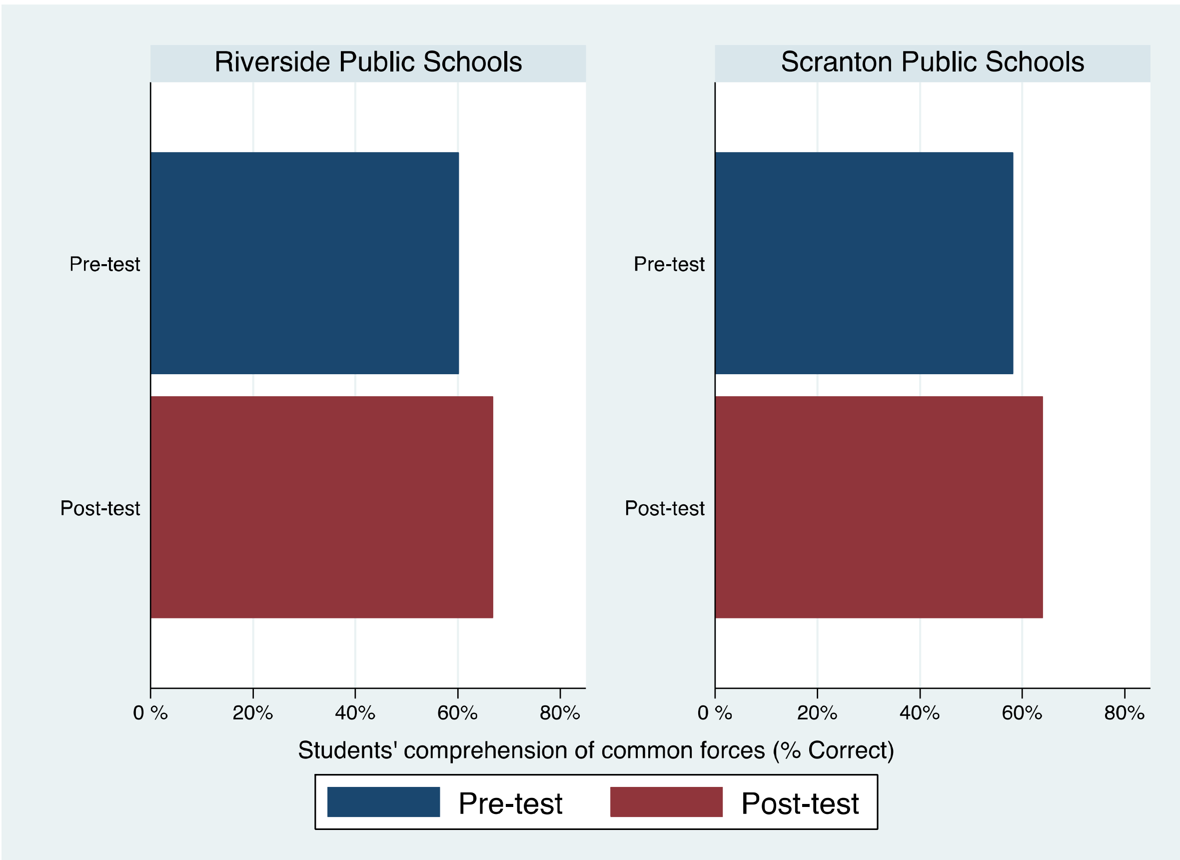
	Student Understanding of the Effects of Common Forces Mean (range 0-100)

	Pre-test Score	Post-test Score	Change
Northeast Scranton Intermediate	54.4	63.5	**+ 9.1**#
West Scranton Intermediate	63.1	65.0	**+ 1.9**
Riverside JSHS	59.5	68.6	**+ 9.0***
All Schools	*59.1*	*65.1*	***+ 6.0***#

Statistically significant change from baseline to follow-up (p<.0001)

* Statistically significant change from baseline to follow-up (p<.01)

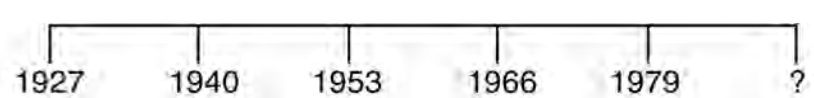
Figure 2. Pre- vs. Post-test Assessments of Students' Comprehension of Common Forces



<u>Students' Ability to Read and Interpret a Timeline</u>

The pre- and post-test questionnaires included two items that asked students to correctly read and interpret a chronological timeline. The specific items included the following:

Table 9. Chronological Timeline Assessment Items

Question #	Assessment Item
21	Which of the following is the missing year that belongs in the timeline below? 

	❑ 1994 ❑ 1992 ❑ 2005 ❑ 1953
22	The timeline below includes a starting and end year, but the years in between are not labeled.  What is the correct scale for this timeline? ❑ 3 years ❑ 5 years ❑ 14 years ❑ 2 years

YSI created a measure of students' ability to correctly interpret a chronological timeline using the items above. Possible values for this measure ranged from 0 (indicating 0 correct responses) to 100 (indicating that the students answered all questions correctly).

As seen in Table 10 below, students demonstrated a significant increase in their ability to read and interpret a timeline. A paired-samples t-test was conducted to compare students' knowledge at the beginning and conclusion of the Bridges program.

There were significant improvements in measured pre-test vs. post-test timeline comprehension skills observed for students participating in both Riverside and Scranton public schools. At the participating Scranton schools, the mean pre-test score was 61% (M=61.1, SD=36.5). After 8 weeks of the program, Scranton students scored an average of 69% (M=68.8, SD=34.6) on the post-test assessment. This represents an average improvement of 8% observed over the course of the 8 week intervention ($M_{difference}$=7.8, SD=42.9); t (482)=4.0, p < .0001. At the Riverside JSHS, the mean pre-test score for participating 7^{th} grade students was 61% (M=61.4, SD=36.8). After 8 weeks of the program, Riverside students scored an average of 70% (M=69.7, SD=35.9) on the post-test assessment. This represents an average improvement of 8% observed over the course of the 8 week intervention ($M_{difference}$=8.1, SD=41.0); t (116)=2.1, p < .05. Figure 3 below presents a visual representation of the pre-test vs. post-test comparison for both participating Scranton and Riverside students.

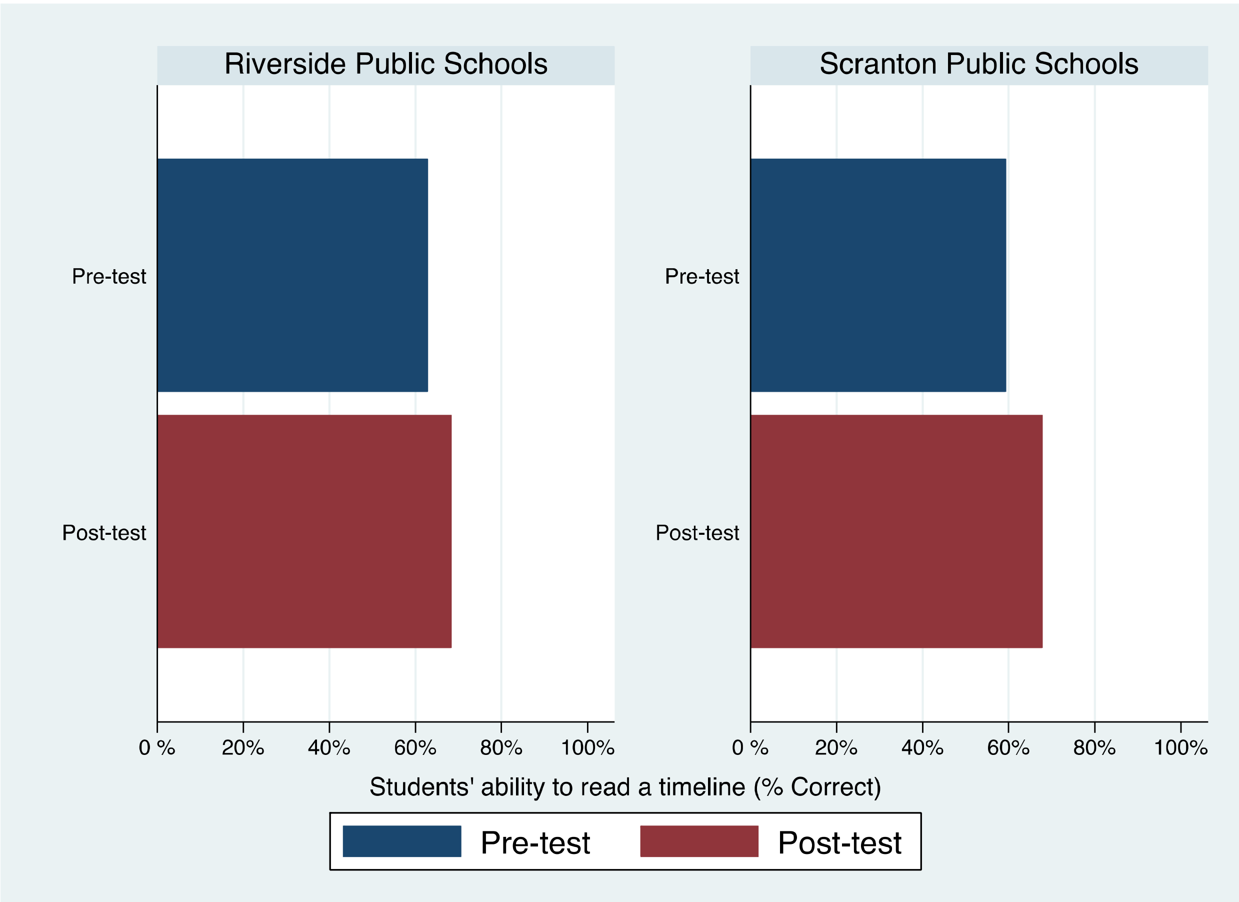
Table 10. Pre- vs. Post-test Assessments of Students' Ability to Read and Interpret a Chronological Timeline

	Students' Ability to Correctly Interpret a Timeline Mean (range 0-100)		
	Pre-test Score	Post-test Score	Change
Northeast Scranton Intermediate	61.6	71.8	**+ 10.2**[%]
West Scranton Intermediate	60.7	66.3	**+ 5.6^**
Riverside JSHS	61.5	69.7	**+ 8.1**[^]
All Schools	*61.2*	*69.0*	***+ 7.8***[#]

[#] Statistically significant change from baseline to follow-up (p<.0001)

% Statistically significant change from baseline to follow-up (p<.001)
^ Statistically significant change from baseline to follow-up (p<.05)

Figure 3. Pre- vs. Post-test Assessments of Students' Ability to Read and Interpret a Chronological Timeline



Students' Confidence in their Ability to Succeed in Math and Science

To assess how *Bridges* students' attitudes about math and science may have changed during the year they participated in the program, evaluators administered a modified version of the Fennema-Sherman Attitudes Scale (see description above). Responses to this assessment were used to develop a measure of students' personal *confidence* in their ability to perform well in math and science. These attitudes were assessed prior to and after students participated in *Bridges*. The assessment items included:

Table 11. Student Confidence Items

Question #	**Confidence Item** **(Answer Choices: Strongly Disagree, Disagree, Agree, Strongly Agree)**
6	I am sure I can learn math
7	I know I can do well in science
8	I think I could do advanced math and science
9	Math is hard for me
10	I know I can do well in math
13	Science is hard for me
15	I am sure I can learn science

YSI created an overall measure of students' math and science self-efficacy. Possible values for this measure ranged from 0 (indicating the lowest possible confidence) to 100 (indicating that the students answered reported the highest possible confidence).

As seen in Table 12 below, *Bridges* participants demonstrated a modest, yet statistically significant increase in their confidence that they can be successful in math and science. Statistically significant improvements were observed at both Scranton and Riverside schools. At the participating Scranton schools, the mean pre-test score was 73% (M=72.5, SD=12.5). After 8 weeks of the program, Scranton students scored an average of 76% (M=76.2, SD=13.7) on the post-test assessment. This represents an average improvement of 4% observed over the course of the 8 week intervention ($M_{difference}$=3.7, SD=9.6); $t(398)=7.7$, $p < .0001$. At the Riverside JSHS, the mean pre-test score for participating 7th grade students was 73% (72.7, SD=13.6). After 8 weeks of the program, Riverside students scored an average of 80% (M=79.7, SD=13.7) on the post-test assessment. This represents an average improvement of 7% observed over the course of the 8 week intervention ($M_{difference}$=7.0, SD=9.3); $t(89)=7.1$, $p < .0001$. Figure 4 below presents a visual representation of the pre-test vs. post-test comparison for both participating Scranton and Riverside students.

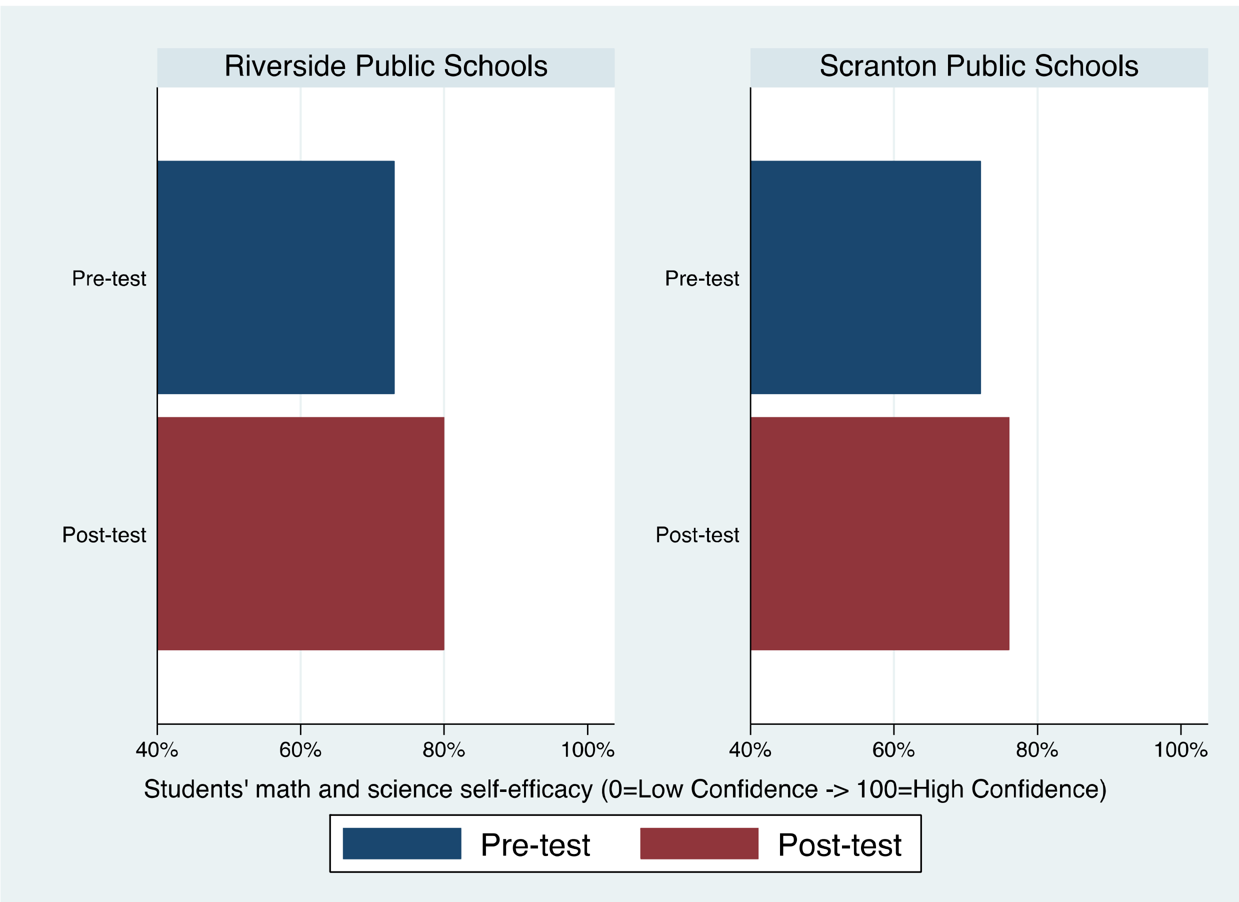
Table 12. Pre- vs. Post-test Assessments of Students' Confidence in their Ability to Succeed in Math and Science

	Math and Science Confidence Mean: range 0 (low) - 100 (high)		
	Pre-test Score	Post-test Score	Change
Northeast Scranton Intermediate	73.3	78.1	**+ 4.8#**
West Scranton Intermediate	71.9	74.8	**+ 2.9#**
Riverside JSHS	72.7	79.7	**+ 7.0#**
All Schools	*72.6*	*76.9*	***+ 4.3#***

* Statistically significant change from baseline to follow-up (p<.01)

\# Statistically significant change from baseline to follow-up (p<.0001)

Figure 4. Pre- vs. Post-test Assessments of Students' Confidence in their Ability to Succeed in Math and Science



<u>Students' Future-oriented Motivation to Pursue Science Careers</u>

The *Bridges* participant survey included three items to measure students' motivation to pursue future education and careers in math and science. These items included:

Table 13. Future-Oriented Motivation Assessment Items

Question #	**Motivation Item** (Answer Choices: Strongly Disagree, Disagree, Agree, Strongly Agree)
11	I would like to work in a career involving science.
12	I would like to study science when I go to college.
14	I would like to work on science projects as an adult.

YSI created an overall measure of students' motivation to pursue STEM-related careers. Possible values for this measure ranged from 0 (indicating the lowest possible motivation) to 100 (indicating that the students answered reported the highest possible motivation).

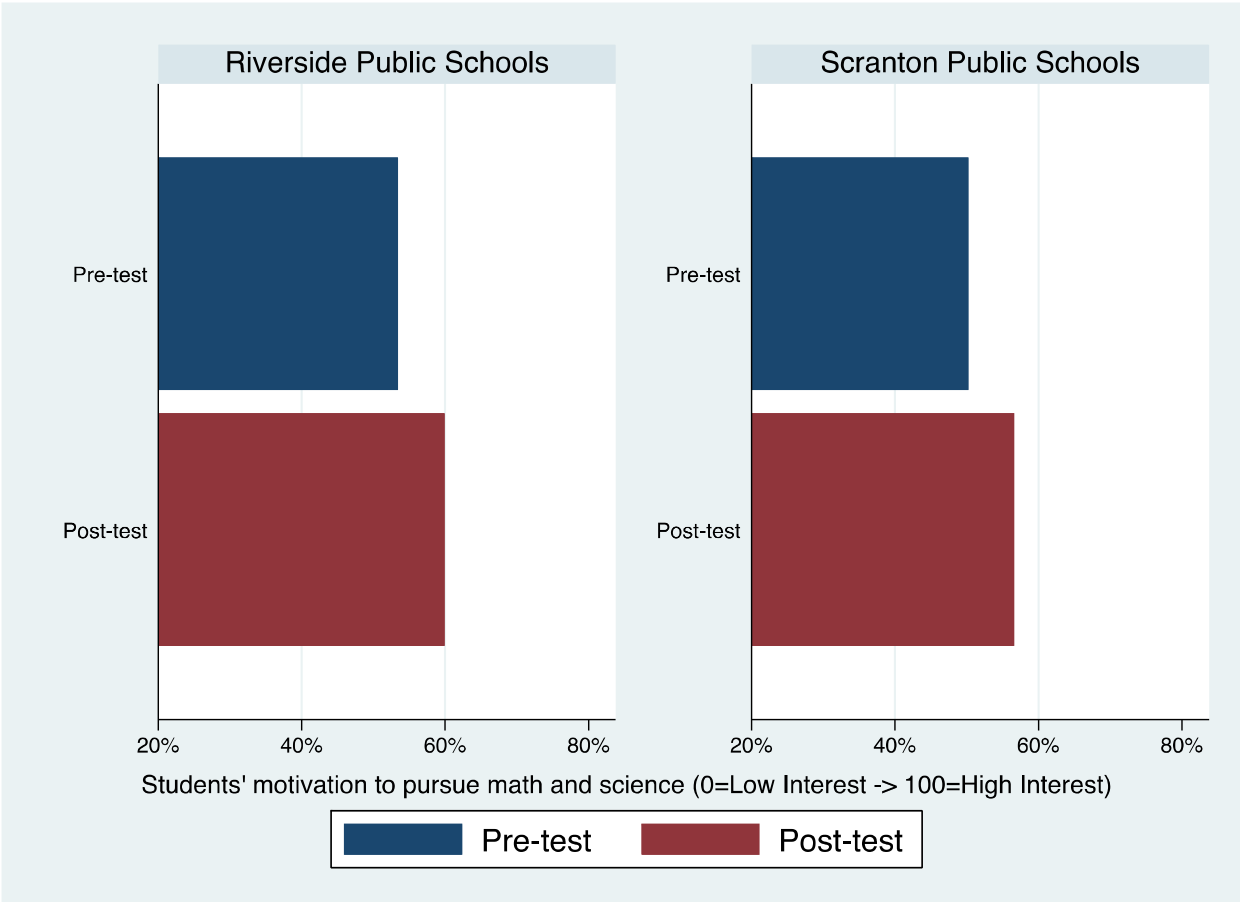
As seen in Table 14 below, *Bridges* participants demonstrated a modest, yet statistically significant increase in motivation to pursue educational and career choices in math and science. Statistically significant improvements were observed at both Scranton and Riverside schools. At the participating Scranton schools, the mean pre-test score was 50% (M=50.2, SD=18.9). After 8 weeks of the program, Scranton students scored an average of 57% (M=56.7, SD=19.5) on the post-test assessment. This represents an average improvement of 6.4% observed over the course of the 8 week intervention ($M_{difference}$=6.4, SD=16.3); t (437)=8.2, p < .0001. At the Riverside JSHS, the mean pre-test score for participating 7th grade students was 54% (M=54.4, SD=19.6). After 8 weeks of the program, Riverside students scored an average of 60% (M=59.8, SD=20.7) on the post-test assessment. This represents an average improvement of 5.5% observed over the course of the 8 week intervention ($M_{difference}$=5.5, SD=13.1); t (94)=4.1, p < .0001. Figure 5 below presents a visual representation of the pre-test vs. post-test comparison for both participating Scranton and Riverside students.

Table 14. Pre- vs. Post-test Assessments of Students' Future-Oriented Science Motivation

	STEM Motivation Mean: range 0 (low) - 100 (high)		
	Pre-test Score	Post-test Score	Change
Northeast Scranton Intermediate	52.1	58.1	**+ 6.0$^{\#}$**
West Scranton Intermediate	48.8	55.5	**+ 6.8$^{\#}$**
Riverside JSHS	54.4	59.8	**+ 5.5$^{\#}$**
All Schools	*50.9*	*57.2*	***+ 6.3$^{\#}$***

$^{\#}$ Statistically significant change from baseline to follow-up (p<.01)

Figure 5. Pre- vs. Post-test Assessments of Students' Future-Oriented Science Motivation



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Appendix A: Bridges Participant Assessment

FORM #1

1-4 OUR ID# 5-6=08

8-10

☐ Pre-Survey ☑ Post-Survey

Student ID: 1

11-20 SITE ID#

salvadori CENTER

Bridges, 2016-17

100%

21-40 | 41-60

N	o	a	h								P	a	r	c	h	i	n	s	k	i				

FIRST NAME (Print in boxes) **LAST NAME**

Dear Salvadori Center Participant:

We are asking students to fill out this survey to help us improve our programs. This is not a test, but rather a questionnaire that gives us an idea of how knowledge grows over the course of our programs. We appreciate and thank you for your participation!

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(61) 1. Have you participated in a Salvadori Center program before? (*Check one*)

☑$_1$ Yes ☐$_0$ No (If your answer is **NO**, you can skip to question #3)

2. If you answered **YES** to Question #1, which Salvadori Center programs did you participate in? (*Please check all that apply*)

(62) ☐$_1$ Skyscrapers (63) ☐$_2$ Skateparks (64) ☐$_3$ Building Green (65) ☑$_4$ Bridges

(66) ☐$_5$ My Community (67) ☐$_6$ Animal Habitats (68) ☐$_7$ Landmarks, Monuments & Memorials (69) ☐$_8$ Ancient Greece

(70) 3. Are you... ☑$_0$ Male (a boy) ☐$_1$ Female (a girl)

4. What grade are you in? *[Check only one box.]*

(71)

☐$_0$ Kindergarten	☐$_3$ 3rd grade	☐$_6$ 6th grade
☐$_1$ 1st grade	☐$_4$ 4th grade	☑$_7$ 7th grade
☐$_2$ 2nd grade	☐$_5$ 5th grade	☐$_8$ 8th grade

5. What is your ethnicity? *[Please check all that apply.]*

72 ☑$_1$ White	74 ☐$_3$ Native American	76 ☐$_5$ Hispanic/Latino
73 ☐$_2$ Black	75 ☐$_4$ Asian or Pacific Islander	77 ☐$_6$ Other: ________

8wk

Please circle the number that shows how you feel about each of the following statements:

		Strongly Agree	Agree	Disagree	Strongly Disagree
78	6. I am sure I can learn math	1	2	3	4
79	7. I know I can do well in science	1	2	3	4
80	8. I think I could do advanced math and science	1	2	3	4
81	9.Math is hard for me	1	2	3	4
82	10. I know I can do well in math	1	2	3	4
83	11. I would like to work in a career involving science	1	2	3	4
84	12. I would like to study science when I go to college	1	2	3	4
85	13. Science is hard for me	1	2	3	4
86	14. I would like to work on science projects as an adult	1	2	3	4
87	15. I am sure I can learn science	1	2	3	4
88	16. I'm very good at working with other students	1	2	3	4
89	17. I'm good at taking tur ns and sharing things with others	1	2	3	4
90	18. I know how to give helpful advice to other students	1	2	3	4
91	19. I know how to cooperate with other students to achieve a goal.	1	2	3	4
92	20. I know how to plan out the steps for a complex project.	1	2	3	4

21. Which of the following is the missing year that belongs in the timeline below?

1927 1940 1953 1966 1979 ?

93 ☐ 1994 ☐ 1992 ☐ 2005 ☐ 1953

1 2 3 4

22. The timeline below includes a starting and end year but the years in between are not labeled.

1960 1974

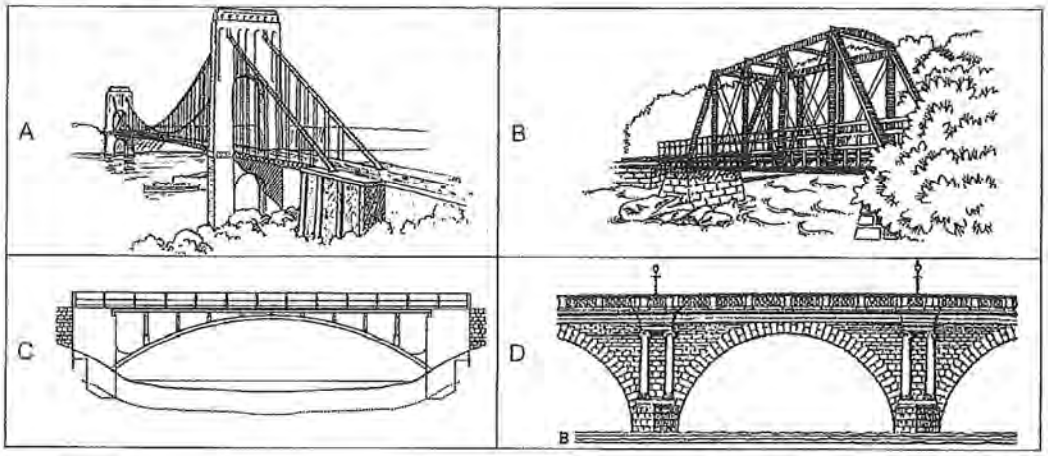
94 What is the correct linear scale for this timeline?

☐ 3 years ☐ 5 years ☐ 14 years ☐ 2 years

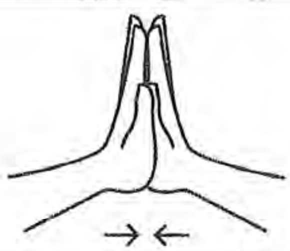
1 2 3 4

23. Match the following types of bridges with the correct name.

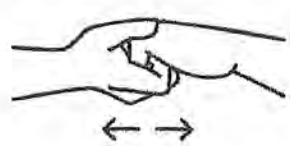
Bridge Type	Letter
Suspension Bridge	A
Arch Bridge	D
Truss Bridge	B
Beam Bridge	C



24. <u>Check</u> which force is being used in each picture below.



- [ ] Tension
- [x] Compression



- [x] Tension
- [ ] Compression

25. When all other things are equal, which of the following is true about a beam bridge?

- [x] The shorter the main span, the stronger the beam bridge.
- [ ] The longer the main span, the stronger the beam bridge.

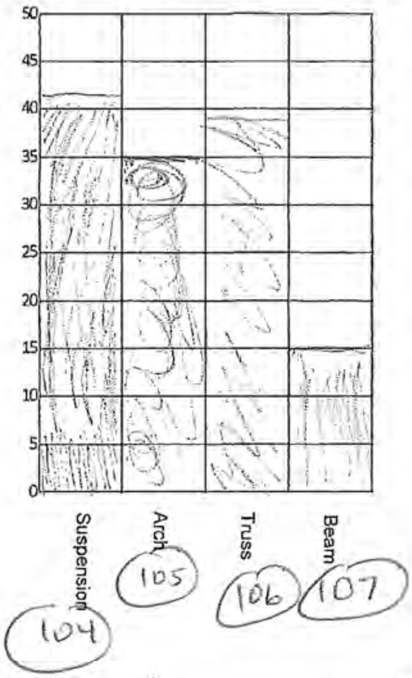
26. What is the definition of a hypothesis?

- [ ] A method for constructing bridges
- [ ] A test used to determine how much force is used
- [ ] ~~A list of~~ materials used in an experiment
- [x] An idea about what the results of an experiment will be

1 = Correct
0 = INCorrect

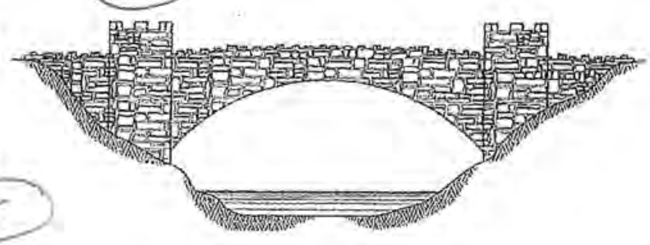
27. The students at a local elementary school were asked about their favorite types of bridges. The table below shows the results of this survey. Create a bar graph showing the results listed in the table.

Favorite Type of Bridge	Number of Students
Suspension	42
Arch	35
Truss	39
Beam	15



28. The image to the right is a picture of an arch bridge. If a truck weighing 500 pounds crosses this bridge, how will the weight of the truck be distributed? (108-111)

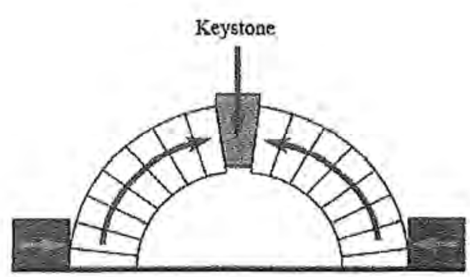
250 pounds will be distributed to the right side of the arch and 250 pounds will be distributed to the left side of the arch. (112-115)



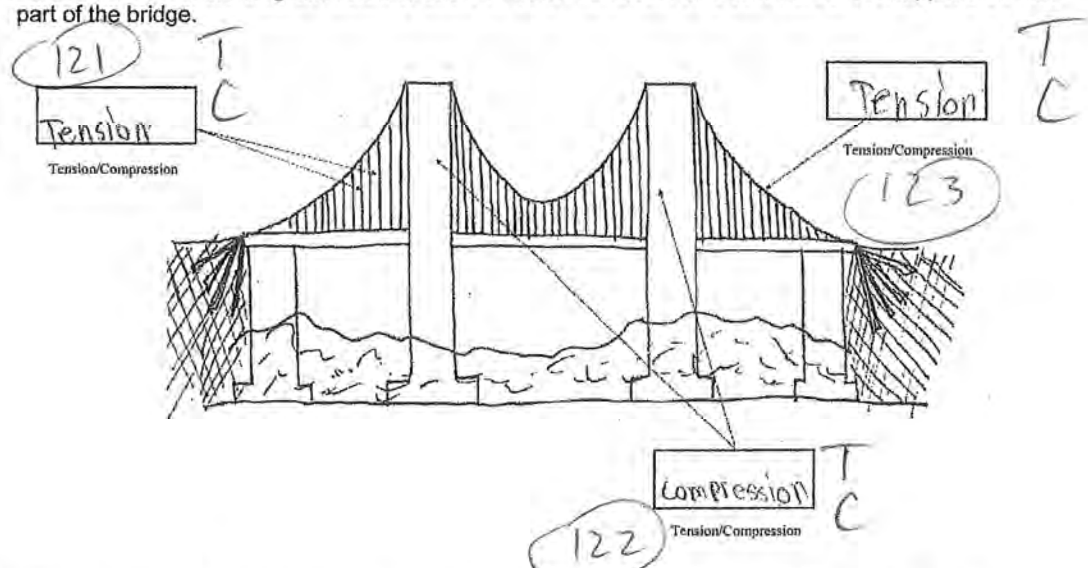
29. Newton's Third Law states that for every action there is an equal and __________ reaction. (116)
1 ☑ opposite
2 ☐ perfect
3 ☐ stable
4 ☐ positive

30. If a pile of snow pushes down on the keystone of an arch bridge so that 25N are distributed to the left side of the bridge, how much force will the ground "push back" with on that side of the bridge?

25 Newtons (117-120)



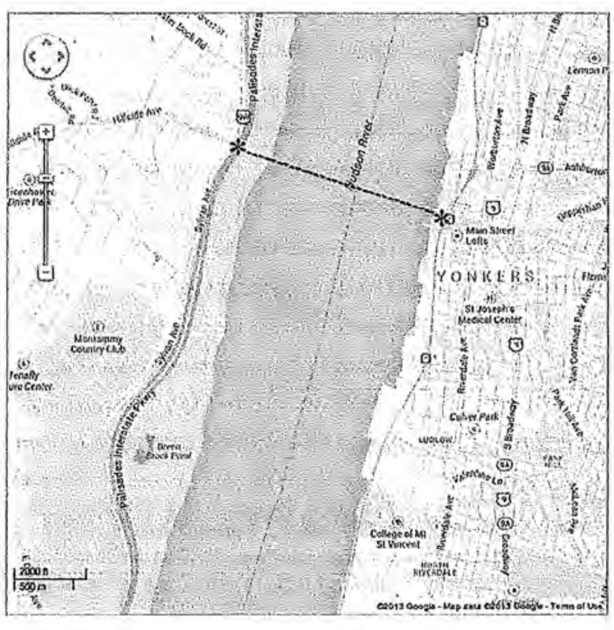
31. Label each box in the diagram below to show whether TENSION or COMPRESSION happens on that part of the bridge.



32. The map below shows the location for a proposed bridge that would connect Yonkers, NY to Englewood, NJ. Using the map scale found at the bottom of the map, estimate what the actual length of the proposed bridge will be.

The proposed bridge will be 6000 feet long.

(124-1307)



SKIP

33. The following is the budget for a proposed bridge construction project. The project will require 30 feet of materials and a construction team of 10 laborers. Use this information to fill in the missing values below, then calculate the ***total*** budget for this project.

Site Development	$ 12,000
Elevation Sketch	$ 6,500
Materials ($4,000 per foot)	$ ______
Labor ($350 per team member)	$ ______
Total Budget	$ ______

34. The *scientific inquiry process* is a way to ask and answer scientific questions by making observations and doing experiments. Which of the following represents the correct order of the steps involved in this process?

- ☐ Step 1) Conduct an experiment, 2) Analyze your data and draw a conclusion, 3) Record your results, 4) State a hypothesis
- ☐ Step 1) Conduct an experiment, 2) Record your results, 3) State a hypothesis, 4) Analyze your data and draw a conclusion
- ☐ Step 1) State a hypothesis, 2) Conduct an experiment, 3) Record your results, 4) Analyze your data and draw a conclusion
- ☐ Step 1) Conduct an experiment, 2) State a hypothesis, 3) Record your results, 4) Analyze your data and draw a conclusion

35. In the space below, use your ruler to draw a straight line that is exactly 5 inches long.

36. Raise your hand when you get to this step!

For your final task, you will be given a small plastic baggie and a single art straw. Your task is to use a ruler to measure and cut this straw into **two smaller pieces** that are exactly **4 inches** and **2.5 inches** long.

When you are finished, put the two final straws (4 inches and 2.5 inches) into the plastic bag and label your baggie as instructed by your teacher.