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Teaching Science Through Active Learning: Sports

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Department of Education

Middle Level Education Science Honors Research Project

TEACHING SCIENCE THROUGH ACTIVE LEARNING: SPORTS

ABSTRACT

Students have a variety of different learning styles and cognitive abilities, so when teaching abstract concepts in areas like science it is often hard to engage and develop all of the students in a class. This project focuses on middle school students and more specifically how they learn physical science. Students often struggle to understand physics concepts because many of them are complex or abstract. So, instead of lecturing about physics to kids, which is proven to have a very low retention rate, this case study tests to see if using something more concrete like sports will help them better understand these more complex physics concepts. The Case Study: Flipping for Physics was done in addition to the research to determine how teaching through sports affects students understanding of forces and motion. This study was conducted on a collective group of 20 eighth grade students that attend a variety of public schools in Ohio. The students were tested on their knowledge of physics, particularly forces and motion that align with the Ohio State Standards adopted in 2011, and that are taught in in all the schools that the students attend.

The students then went through a 50-minute lesson taught using active learning/ learning through sports focused on the gymnastics vaulting apparatus to explain and explore the physics phenomena. The activity was student centered and throughout the activity the students were actively engaged in inquiry-based activity and collaboration to develop their understandings of the physics principals that they were originally tested on. They then took a post-test that was compared to the pre-test to gauge their level of growth on the subject. As well as a survey on their experience and thoughts on learning with this teaching style. The results from this case study help to support active learning or teaching through sports to be a best teaching practice

based on student’s content development, scores, and opinion data. Hopefully, this development on teaching through sports can be used by myself and other educators to help teach students with effective practices that encourage their development in the field of science.

TABLE OF CONTENTS

INTRODUCTION

Middle School students are at an interesting time in their development. Since they are at a variety of ages and developmental levels it can be hard to engage all the kids in your class. The students focused on in this study range between 13-15years old. These students are socially and emotionally still developing and are very invested in relationships and interacting with their peers. While, physically these students are growing/going through puberty and developing their bodies and brains. According to Piaget most of these kids fall into either the concrete operational stage formal operational stage of thinking this can be tricky when teaching harder more abstract concepts like physics because some students struggle with the material. (Wadsworth, 1996, n.p)

Many lessons are taught to the visual or auditory learner but in in the survey at the end of this case study most students identified as kinesthetic learners at this age. That means lecture style classes are less effective for them. When surveyed 17/20 of the learners that took part in this case study identified as kinesthetic learners. In order to engage students, you need to have adaptive teaching practices that engage all types of leaners. Active learning does this. Active learning, also called teaching through recreation or teaching through sports is a teaching practice in which the lessons are focused on the students being active and physically involved in learning the content. In math this could mean students running from one side of the room to the other as you add and subtract students while learning. In this case, the students are learning about physical science that aligns 8th grade Ohio State Standards adopted in 2011: PS.8.2.1, PS.8.2.2, PS.8.3.1, PS.8.3.2 (p. 267-285). They are learning about forces and motion and more specifically types of energy and energy transfer. The following research and case study were done to help validate teaching science through sports as a good teaching practice to use with young middle school and adolescent learners. The case study includes a one-hour lesson involving using the sport of gymnastics to teach physics phenomena. The students were pre-tested, engaged in an active learning based self-directed lesson, Post-Tested, and Surveyed about their experience. The data and results from this experiment are used to support teaching science throughs sports as an effective practice as well as encourage other educators to try this type of lesson in their classroom.

PURPOSE

The purpose of this study is to elaborate on education through recreation or active learning and test its effectiveness as a teaching practice in a lesson done with eight grade students. There has been some research done on the benefits of teaching students through activity but much of it is broad or focused on young children, so this case study serves as a more focused study on how teaching through recreation also benefits and aids in teaching middle school students, and hopefully will encourage more teachers to use teaching through sports in their classrooms.

EDUCATIONAL AND PROFFESIONAL REASERCH

When researching materials to support my claim, I found most sources do support teaching science through sports as an effective method. But, do not have much data or examples with middle level learners. The article *Schools Should Teach Science Like Sports* from Scientific American talks about the success of the Next Generation Science Standards. Which are standards for science focused on teaching science through active learning.

They compare an example of teaching a kid to hit a ball. Wysession's article said the following:

> "How would you go about doing it? One approach might be to sit them down and start having them memorize the rules of the game, the dimensions of the field, the names and statistics of past players, and a host of other facts. You would stop teaching them periodically to review the material in preparation for multiple-choice assessment tests. The students who showed a great aptitude for memorizing large numbers of facts could go into honors classes where they would memorize even larger numbers of facts. At the end of the process, without ever leaving the classroom, how well do you think the children would be able to play baseball or softball? More important, how many would even want to?" (2015, n.p)

He also goes on later in the article to state that, "The Next Generation Science Standards (NGSS) are intended to be a cure for this approach. They are the result of a bipartisan, states-led effort at rewriting K–12 science performance expectations in a way that will not only engage and excite students but also allow them to learn science by *doing* science, as opposed to memorizing facts *about* science." This article supports my claim of active learning or learning through sports and doing as an affective teaching practice. It also explains how this style of teaching has increased engagement and retention. This is supported by newly aligned standards to this thinking, research, and test scores. However, as a teacher trying to find tools, resources, and lessons to model this teaching style it is a bit more difficult. Mostly, there are examples for things to do with early learners and complex things to do with higher learners or with collegiate level classes. But middle level science classes would benefit greatly with more lessons and studies done on the affect of this on middle level learners and their developing minds and skills.

When researching for direct lessons, I found the article *A Sporting Chance* on IAcheiveLearning.com that gave examples and links of how to use sports in the classroom to teach science, some examples included active learning, and some included just referring to sports as a base for understanding ideas. While both of these are good, they only mentioned basic level learners/ elementary and higher grades/ high school and post-secondary examples.

Lane gave the following examples:

> "At a basic level, the following link shows how you can teach the simplest of mathematics using football. For instance, basic addition can be modeled (touchdown (7) + field goal (3) = 10 points.) From there, football can be used to teach percentages, averages, and probability. For the higher grades, check out this incredible article from *The New York Times'* Teaching and Learning Network. In it, the authors offer comprehensive information about sports analytics and how it can be integrated into the classroom, including gathering data, analyzing data, visualizing data, explaining the significance of data, and applying analytics." **(**Lane, 2016, n.p)

He gives no examples for middle level learners throughout the cite. Ultimately, there is a wide amount of support for teaching science through sports but a lack of examples and results for how this teaching practice was implemented with middle level learners. So, I created a case study directly relating teaching through sports with middle school students, I pre-tested their abilities, observed their learning, implemented a student lead lab, post-tested them, collected data, and surveyed them for their opinion in order to further support for teaching science through sports especially with middle level learners.

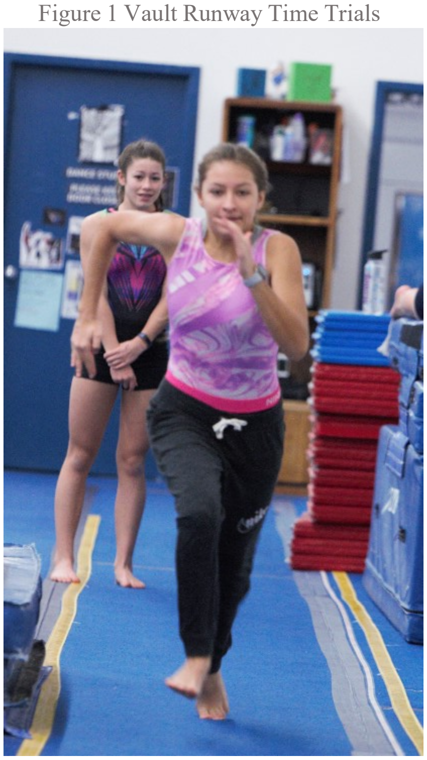
PARTICIPATION CLAIM

All students featured in this case study were informed participants and copies of the parent consent/image release forms are located in the Appendix on page 36. All students pictured are trained gymnasts capable of preforming the skills shown in the figures. Disclaimer: This may not be applicable to all student's abilities in a classroom setting and may need modification if replicated.

CASE STUDY

After researching active learning, I decided to delve more deeply into this teaching practice by teaching science through sports in a full lesson to eighth grade students. Twenty students and their parents/guardians consented to be volunteers for this study. We conducted this study at a gymnastics facility outside of the school. The students arrived and participated in a 1-hour class. While in most middle schools their periods range from about 40 minutes-50 minutes, this lesson would take about a day and a half including set up time. We started the lesson by going over the agenda and giving the students identifying letters for the day. We then took the physics pre-test, on this pre-test there were 12 questions, 10 of which were based on the Ohio State Standards for grades 4-7 Physical Science which should be mastered by these 8th grade students. The last two questions involved Standards from 8th grade and were about Energy, which the students would have already done during the year, could be currently working on, or getting ready to work on. The students acknowledged that they've learned "some of these things before."

Figure 1 Vault Runway Time Trials



After the pre-test I passed out materials for the lab and gave some directions and clarifications about the content, procedure, and safety. The students were then given a student-centered self-guided worksheet to work on and were told to ask for help if needed. The students broke up into 5 groups and had 35/40 minutes to work on their lab sheets. An example of group 2's work is found in the appendix on page 30.

As, the students progressed through the sheet they recorded their results and data. They started of running time trials to calculate velocity and acceleration, they calculated the fastest runner's mass and then use this in the energy section to calculate the force or the run and the force of gravity on the runner. All the students that participated in this study were athletes capable of vaulting so they actually did for part C and D of the worksheet but in a class setting you could use the images and videos for the final sections to get the data. For the last sections the students vaulted and calculated spring energy and the effect of elastic potential energy on the spring board which aligns with PS.8.3.2 Objects can have elastic potential energy due to their compression or chemical potential energy due to the nature and arrangement of the atoms that make up the object.

Figure 2 Normal Spring Board

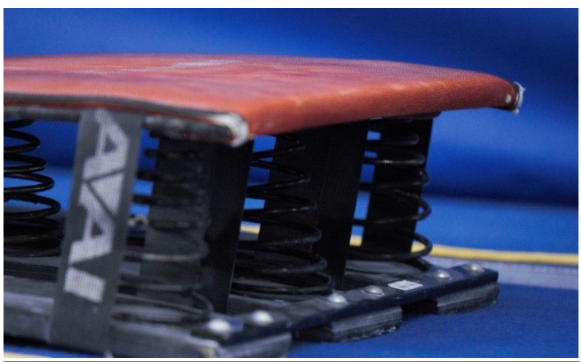


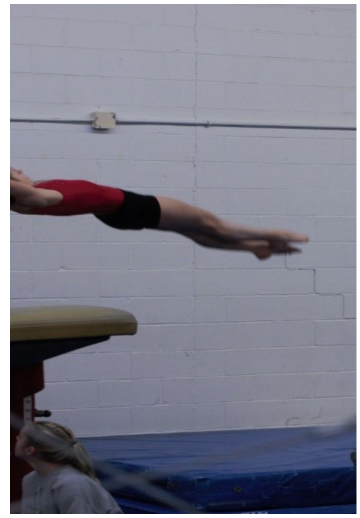
Figure 3 Compressed Spring Board

They discovered how energy transfers as the students apply force to different things like running, the spring board, the vault, and the mat. They examined the effects of Newton's Laws

Figure 4 Newton's 3rd Law

as they observed how objects are a part of balanced forces and how objects interact with one another. In Figure 4 a gymnast is shown pushing on the vault table. In accordance with Newton's 3rd Law every action has an equal and opposite reaction. So, as the gymnast pushes on the vault the vault exerts a force on the gymnast. The observed the effect of the gymnast's force on the vault able by looking at the height the gymnast achieved on the post flight. The students observed the correlation that, the more force you apply to the table the higher the gymnast will pop off in their post flight. They ended by calculating the kinetic and potential energy of the vault and plugging that into an efficiency formula to see how efficient their vaults were.

Figure 5 Post Flight



In making this worksheet engaging for the students and reflective in nature the last page was about elaborating on the content. A best-teaching practice in science is following a 5 E lesson plan which this lesson was based on. Engage, Explore, Explain, Elaborate, Evaluate. The pre-test and my introduction engaged the Students. The worksheet and answers were when the students explored and explained the content. And the last page was elaborating and evaluating. It was about what the students learned and answering their elaborating questions about the content, allowing student to do this helps further their interest in the content and builds up their knowledge about the subject. The student took one question they had left and researched it or tested it and drew a conclusion about their question. They also took what they learned and applied the content in two ways that affect them in the real world so that they are making meaningful connections. Lastly, the students took a post-test as part of the evaluating of the 5 E Lesson. At the very end of the case study the student had 5 minutes to take a survey about their experience and 5 minutes to share out positives about the lab or questions that they still had. The study ran on time and all the students that participated in the study were able to finish all the segments of the study.

RESULTS AND DATA

Table 1

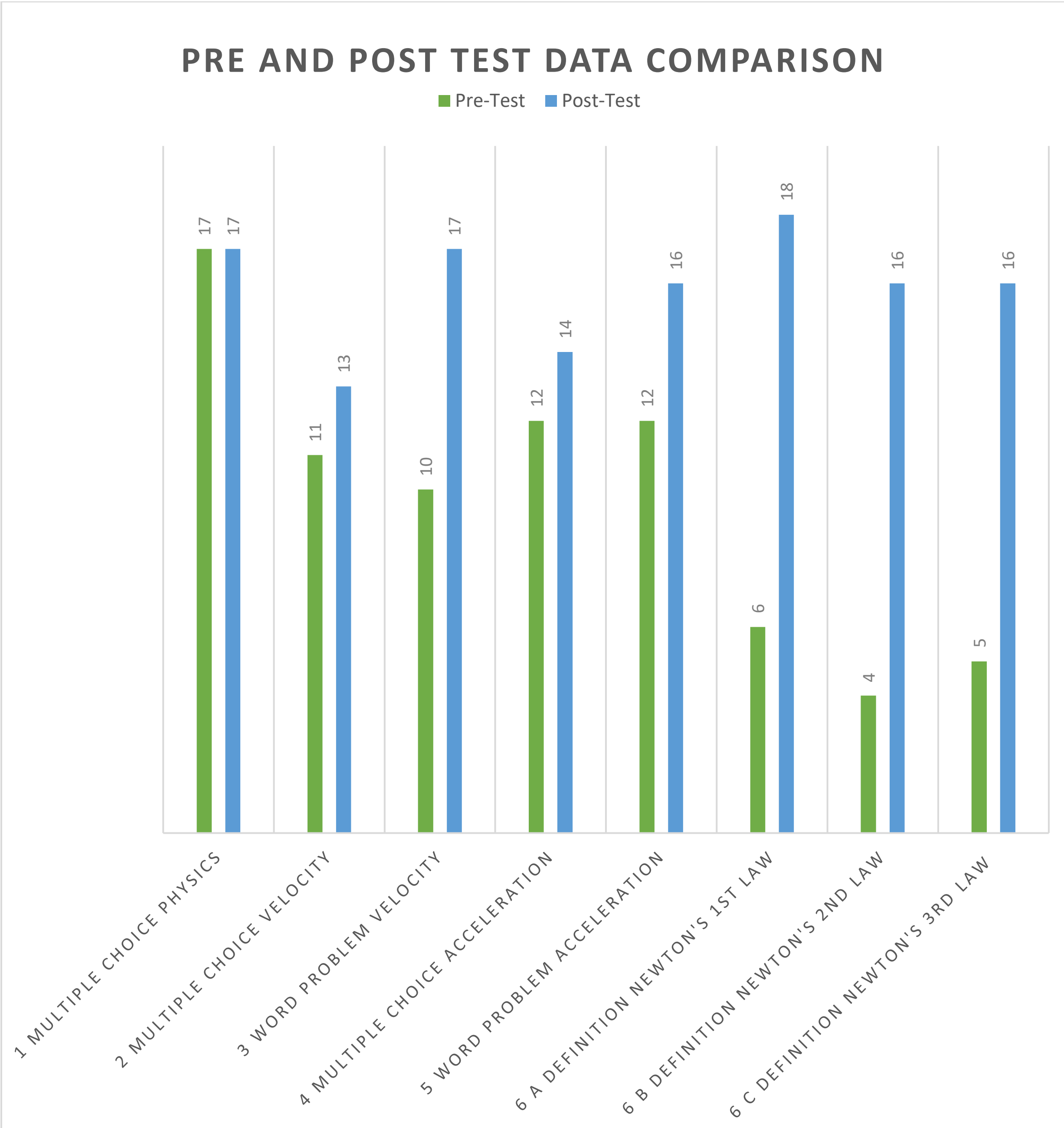
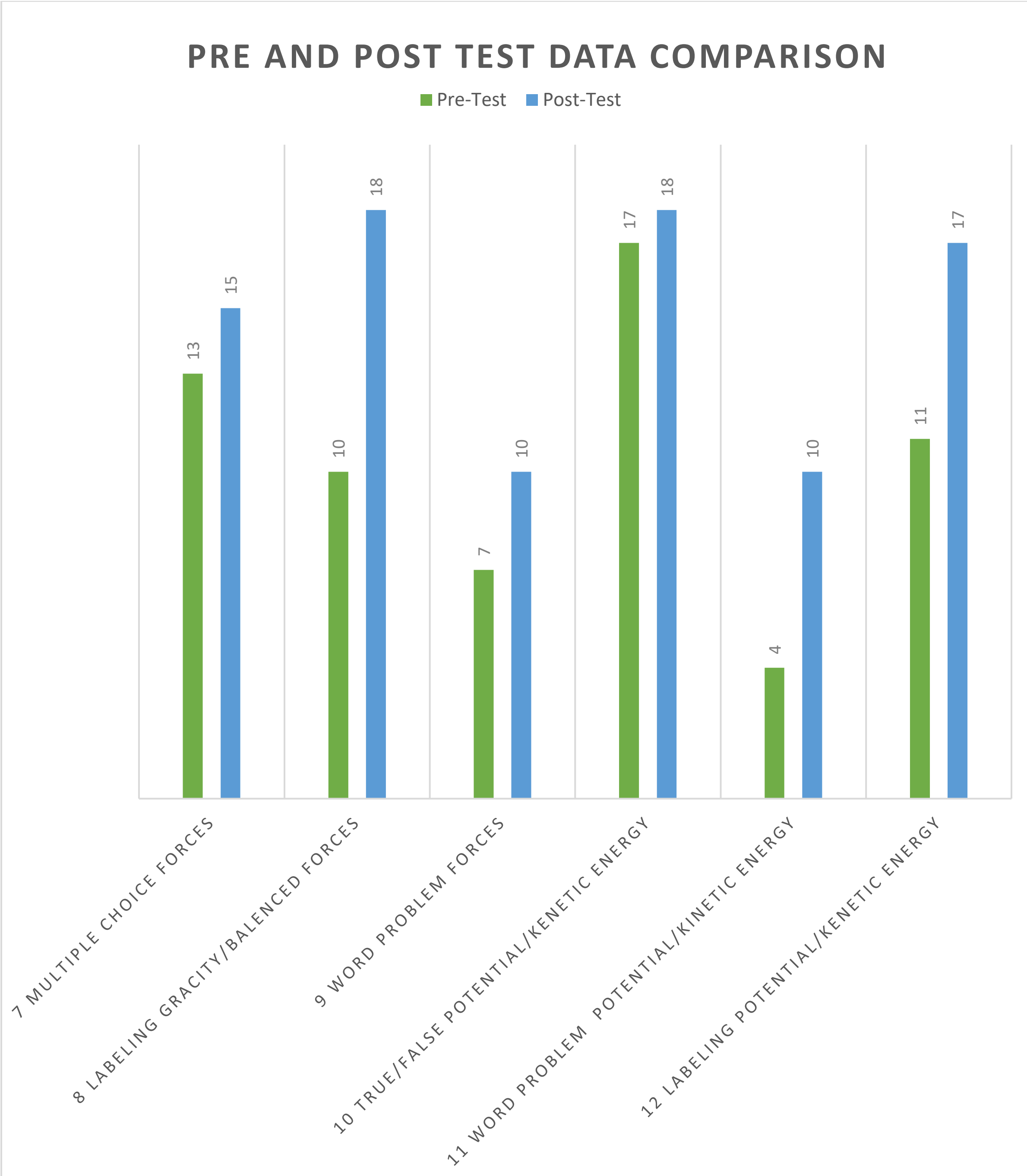


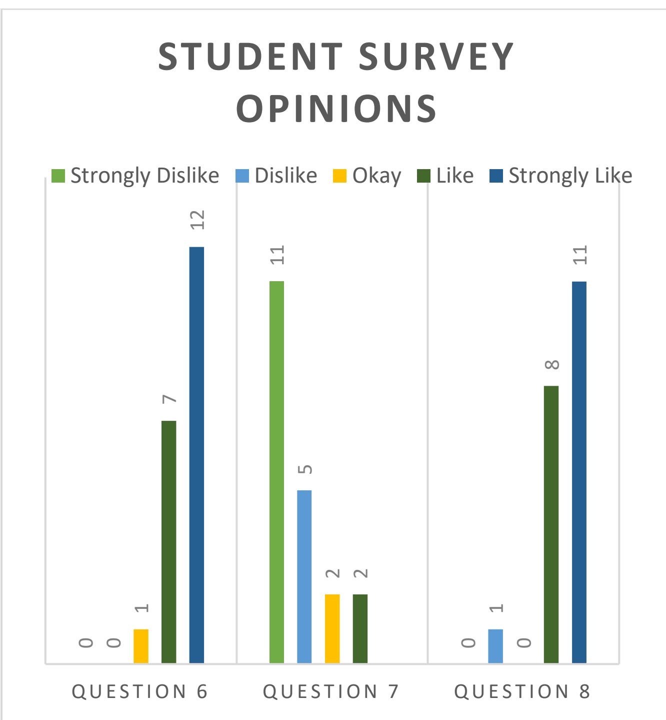
Table 2

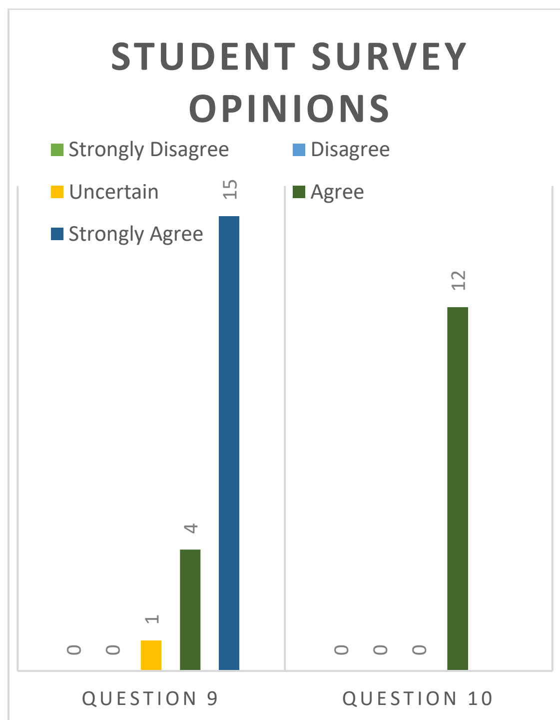

PRE AND POST TEST DATA COMPARISON
Pre-Test
Post-Test
13
15
10
18
7
10
17
18
4
10
11
17
7 MULTIPLE CHOICE FORCES
8 LABELING GRACITY/BALENCED FORCES
9 WORD PROBLEM FORCES
10 TRUE/FALSE POTENTIAL/KENETIC ENERGY
11 WORD PROBLEM POTENTIAL/KINETIC ENERGY
12 LABELING POTENTIAL/KENETIC ENERGY

The data from the pre-test and post-tests gives a lot of insight into the students learning. Examples of an average student's test is found in the appendix under C and D. Student H had scores typical to most students in this study and in analyzing this particular student's assessment data, you can see that they improved a lot after this lesson. Student H's pre-test had a 6/14 score and their post-test had a 12/14 that's double what they scored in the pre-test. In the pre-assessment Student H did well with Multiple choice questions but not as well on word problem questions, definitions or labeling questions. This could mean that the student either has a shallow understanding of the content and couldn't apply their knowledge to more complex problems, didn't know how to complete those problems, or struggles with those types of problems. Regardless Student H still missed 4 questions that were review from previous years standards and two questions about the current content from their 8^{th} grade year. However, in the Post-Test Student H only missed question 5 and 11. Question 5 was asking: A runner accelerates uniformly from 12.1 m/s to 23.6 m/s in 1.25 s determine the acceleration of the runner? Question 11 was asking students to: Find the kinetic energy of the same 49 kg runner using the kinetic energy formula of $KE=1/2m\mathbf{v}^2$. Both of which were application word problems.

This was a trend with many other students as well, they could successfully get multiple choice questions based on memory but couldn't get more complex questions because they didn't seem to thoroughly understand the content and weren't able to apply it. Which according to Bloom's Taxonomy is what we want our students to do in order to show mastery, his hierarchy of learning goes as follows: remember-understand-apply-analyze-evaluate-create. Questions like multiple choice mostly serve to check students remembering of words/terms while word problems and labeling check whether students can apply, analyze, and evaluate the content which shows a deeper understanding (1956, n.p). For example, in the Pre-Test 85% of students were able to recall the answer for question 1, but only about 25% were able to correctly explain Newton's Laws in questions 6A-C. The interesting thing is both question 1 and 6A-C come from the 5th grade standards and the students have used them in their physical science classrooms in grades 5, 6, 7, and now repeated in grade 8, but some still don't understand the concepts. This lack of understanding makes it incredibly hard to build upon these concepts in higher grades and causes students to get left behind or confused. However, after this active learning lesson the Post-Test data shows an increase in accuracy for almost every question. This lesson promotes a higher-level of understanding of the content and then the ability to apply the content mathematically and when problem solving, which leads students to mastery and success with their learning.

Graph 3





Additionally, I collected data on the student's opinions about this learning segment in comparison to their prior experiences as well as their overall learning experiences and preferences.

An example of an average student's responses is found in the reference materials in the appendix on page 23. The first 5 questions were short answer opinion questions that asked. 1. Did you enjoy this lesson? 2. Do you enjoy working in groups/ collaboratively with other students? 3. How did this lesson compare to prior lessons you have had about physics? 4. How do you learn best Visually (seeing material)? Auditory (hearing it from the teacher or students)? Or Kinesthetically/Actively (Physical activities involving the content)? 5. What are some physics ideas you learned in this lesson? But based on the response opinions, question one had a 100% positive response. Question two had a 90% positive response about working collaboratively. Question over 90% of students made a distinctive difference between this lesson and previous lessons that they have experienced. In question four 17/20 students identified as kinesthetic learners, 2 as visual learns, and 1 as an auditory learner. Question five had a variety of responses about what new concepts students gained information about from this lesson, and 100% of kids listed a physics concept relevant to the lesson. For example, the student's response from the survey example in appendix B for question 5 said. "Motion, Kinetic, and Potential Energy, Acceleration, and Speed. These were all the major concepts from the lesson, and they recalled all of them.

The last five questions were rated on a scale. Questions 6-8 were on a scale form strongly like to strongly dislike and questions 9-10 were rated from strongly disagree to strongly agree. The questions asked students what they enjoy, their thoughts, and opinions and the students were asked to circle the response that matches their opinion. These surveys were given at the conclusion of the entire lesson and were completely anonymous so students could answer honestly. These surveys showed a lot of student support for lessons based on teaching science through sports. For example, question six sated, I enjoy active learning like this lesson/lab. And 95% of students circled that they like or strongly like lessons like Flipping for Physics. While in contrast question 7 stated "I enjoy lecture style classroom learning" and only 10% of students circled that they like lecture style teaching and 0% of students circled strongly like lecture lessons. From these answers you can concur that most students enjoyed this lesson, while each student has different preferences and learning styles you can conclude that teaching science through sports is effective with most middle level learners.

CONCLUSION

From the data, results, and surveys this lesson supported teaching science through sports as an effective practice for middle school students. The students enjoyed it and gained valuable information and therefore I believe more lessons should be taught like this in the classroom. While most schools don't have access to the facilities I used, they do have gymnasiums that have similar equipment that can be used for a lesson similar to this. There are many ways teachers could use sports to teach science with students. As, the research on this practice continues to grow more lessons and plans will become available but I hope that this case study and its results can be used by other educators to help better the learning experience for the students in their classrooms. Students are learning best as active participants that can engage in real problem solving and active learning in the classroom is an effective design for that. So, whether you call it learning through recreation, teaching through sports, or active learning this is a practice that should be incorporated more and can be used to have more impactful lessons with students.

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APPENDIX

A. Class Schedule

Class Schedule Honors Project: Teaching Science Through Sports

Allotted Time: 1 hour

0:00-0:05- Students take Physics Pre-Assessment

0:05-0:10 Directions for worksheet and activity are given as well as all materials are passed out (Stopwatches, calculators, pencils, clipboards, and papers)

0:10-0:45 Students work in groups on worksheet

Part A: Runway Sprint Times
Students in their groups will time each other running the length of the run way. Using the formula for acceleration and velocity they will determine the speed and acceleration of the runs.

Part B: Vault Potential V Kinetic Energy
A student will vault and using a tape measure against the wall read the height that the student obtained with the height, the previous acceleration measurements and other calculations will determine the kinetic and potential energy as well as create an energy diagram

Part C: Efficacy and Newton's Laws
Students will compare the Kinetic and potential energy for efficacy as well as use the stages of the vault to describe Newton's 3 laws of motion.

0:45-0:50 Students take Physics Post-Assessment and turn in worksheet and data

0:50-0:55 Students take survey on lesson

0:55-1:00 Group discussion and reflection on lesson students can ask any additional questions as well as give comments or findings aloud to the group

B Survey Example

Learning Science Through Sports Survey

You can answer all questions honestly this survey is completely anonymous

1. Did you enjoy this lesson?

Yes, it was fun.

2. Do you enjoy working in groups/ collaboratively with other students?

Yes, I learn more with groups.

3. How did this lesson compare to prior lessons you have had about physics?

I had more fun and understood it better.

4. How do you learn best Visually (seeing material)? Auditory (hearing it from the teacher or students)? Or Kinesthetically/Actively (Physical activities involving the content)?

Actively

5. What are some physics ideas you learned in this lesson?

Motion + Potential and Kinetic Energy; Acceleration + speed

For questions 6-8 Rate your answer as

SD=Strongly Dislike D=Dislike O=Okay L=Like SL=Strongly like

6. I enjoy active learning like this lesson/lab. SD D O L (SL)

7. I enjoy lecture style classroom learning. (SD) D O L SL

8. I enjoy collaboration/group work. SD D O L (SL-)

For Questions 9-10 Circle your answer as

SD= Strongly Disagree D= Disagree U=Uncertain A=Agree SA=Strongly Agree

9. I feel like I better understand physics concepts after this lesson. SD D U A (SA)

10. I think there should be more lessons like this taught in the classroom SD D U A (SA)

C Student H Pre-Test

Student Letter H

Physics Pre-Test

1. What is Physics?
a. The branch of science that studies the human body and its functions
(b) The branch of science that studies the nature and properties of matter and energy
c. The branch of science that studies the physical composition of the earth and it's atmosphere
d. The branch of science that studies atoms and chemical compounds

2. What is Velocity?
(a) The rate of change of its position with respect to a frame of reference
b. A vector whose length is the shortest distance from the initial to the final position of a point
c. The rate of change of the velocity of an object with respect to time
d. A scalar quantity that is the rate at which an object covers distance.

3. Jason starts at 8 meters facing North on a 100-meter track, he runs the rest of the length of the track in 8 seconds, what was his velocity?

Answer: 11.5 mps

4. What is acceleration?
a. The rate of change of its position with respect to a frame of reference
b. A vector whose length is the shortest distance from the initial to the final position of a point
c. The rate of change of the velocity of an object with respect to time
(d) A scalar quantity that is the rate at which an object covers distance.

5. A runner accelerates uniformly from 12.1 m/s to 23.6 m/s in 1.25 seconds, determine the acceleration of the runner?

Answer: 1.95

6. What are Newtons 3 Laws of Motion?

Newton's 1st Law of Motion:
When something is in motion it stays in motion unless acted upon by an unbalanced force.

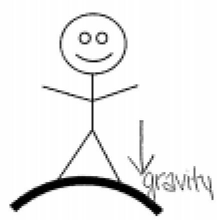
Newton's 2nd Law of Motion:
Every action has an equal and opposite reaction

Newton's 3rd Law of Motion:
?

7. What is a force?

a. Measure of energy transfer that occurs when an object is moved over a distance by an external force
b. The quantitative property that must be transferred to an object in order to perform work on, or to heat the object
(c.) Any interaction that, when unopposed, will change the motion of an object
d. A scalar quantity that is the rate at which an object covers distance.

8. This person is standing on the Erath label all of the forces acting on him with arrows and the type of force.



9. A 49 kg runner starts from rest and reaches a maximum velocity of 6.64 m/s in 3 seconds. Using Newton's 2nd Law determine the force produced during the run?

Answer: 2.21

10. Kinetic energy is the energy possessed by an object because of its position relative to other Objects?

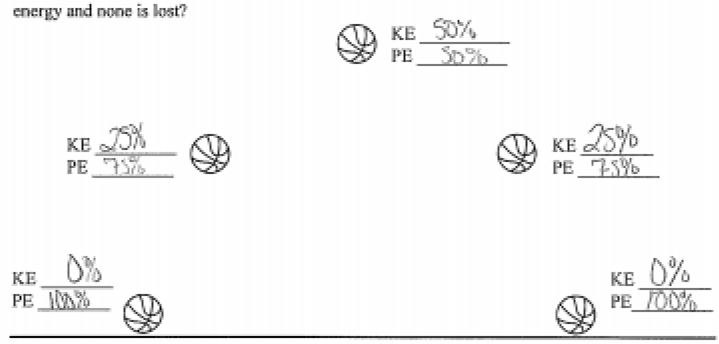
a. True

(b) False

11. Find the Kinetic Energy of the same 49 kg runner using the Kinetic energy formula of $KE = 1/2mv^2$

Answer: 7.37

12. Using the images below of the bouncing basketball projectile label the amount of kenetic and potential energy at each stage as a percentage of the total energy if KE and PE were 100% of the energy and none is lost?



D Student H Post-Test

Student Letter H

Physics Post-Test

1. What is Physics?

a. The branch of science that studies the human body and its functions

(b) The branch of science that studies the nature and properties of matter and energy

c. The branch of science that studies the physical composition of the earth and it's atmosphere

d. The branch of science that studies atoms and chemical compounds

2. What is Velocity?

(a) The rate of change of its position with respect to a frame of reference

b. A vector whose length is the shortest distance from the initial to the final position of a point

c. The rate of change of the velocity of an object with respect to time

d. A scalar quantity that is the rate at which an object covers distance.

3. Jason starts at 8 meters facing North on a 100-meter track, he runs the rest of the length of the track in 8 seconds, what was his velocity?

$100 - 8 = \frac{92}{8} =$

Answer: 11.5 mps

4. What is acceleration?

a. The rate of change of its position with respect to a frame of reference

b. A vector whose length is the shortest distance from the initial to the final position of a point

(c) The rate of change of the velocity of an object with respect to time

d. A scalar quantity that is the rate at which an object covers distance.

5. A runner accelerates uniformly from 12.1 m/s to 23.6 m/s in 1.25 seconds, determine the acceleration of the runner?

Answer: 92

6. What are Newtons 3 Laws of Motion?

Newton's 1st Law of Motion:
An object in motion stays in motion unless acted on by an outside force.

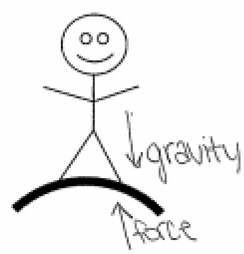
Newton's 2nd Law of Motion:
F=mA

Newton's 3rd Law of Motion:
Every action has an equal and opposite reaction.

7. What is a force?

a. Measure of energy transfer that occurs when an object is moved over a distance by an external force
b. The quantitative property that must be transferred to an object in order to perform work on, or to heat the object
(c) Any interaction that, when unopposed, will change the motion of an object
d. A scalar quantity that is the rate at which an object covers distance.

8. This person is standing on the Erath label all of the forces acting on him with arrows and the type of force.



9. A 49 kg runner starts from rest and reaches a maximum velocity of 6.64 m/s in 3 seconds. Using Newton's 2nd Law determine the force produced during the run?

6.64/3 = 2.21
x 49

Answer: 108.29 N

10. Kinetic energy is the energy possessed by an object because of its position relative to other Objects?

a. True

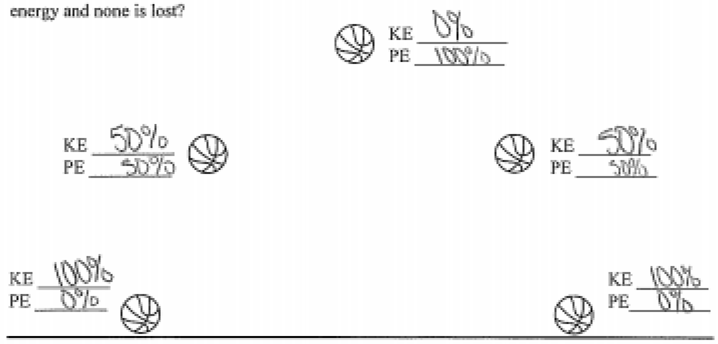
(b.) False

11. Find the Kinetic Energy of the same 49 kg runner using the Kinetic energy formula of $KE= 1/2mv^2$

$1/2 \times 49 \times 6.64^2$

Answer: 162.68

12. Using the images below of the bouncing basketball projectile label the amount of kenetic and potential energy at each stage as a percentage of the total energy if KE and PE were 100% of the energy and none is lost?



E Group 2 Worksheet

Student Letter: H Groupmates Letters I L M

Teaching Science Through Sports Worksheet

Please read each section's directions carefully and if you have any questions please ask the instructor

Materials: Please make sure you have or have access to all the materials

Stopwatch

Calculator

Scale

I Pad (Coach My Video App)

Laptop

Part A: Newtons Laws:

Newton's 1st Law of Motion: Inertia

objects in motion stay in motion unless an outside force is acted on it

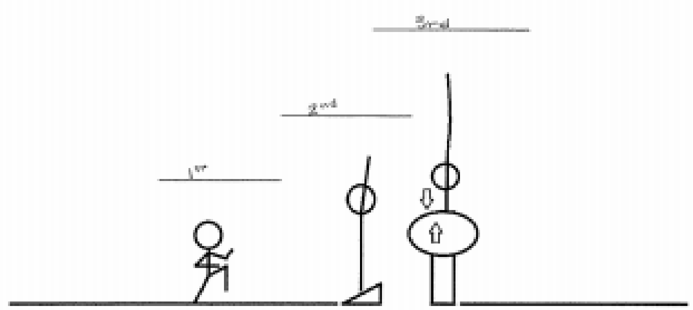
Newton's 2nd Law of Motion: Net Force F=ma

Force = mass times acceleration

Newton's 3rd Law of Motion: Action/Reaction Forces

For every action there's an opposite & equal reaction

On the diagram below match a Newton's law to each part of the vault



Part B: Velocity and Acceleration

Now in your groups each of you is going to do a timed runway run and then will solve for your own velocity and acceleration.

Start at 60 feet on the runway strip and run 2 sprints while your group members time and then solve for your average time (Start timer when student moves stop when student hurdles at the board at 5 feet away from the vault)

Student Letter	Run #1	Run #2	Average Time
H	3.41		3.41
I	3.71		3.71
L	2.87		2.87
M	2.76		2.76 ★

Convert the distance in feet you run into meters with this conversion formula:

Meters= Ft/3.2808

Answer: 16.76 meters

Make Predictions! What do you think your average velocity was in m/s?
(The Velocity of cheetah's Average sprint is about 31 m/s)

5 m/s

Now solve for your velocity using the formula **V=D/T** with the direction being North.

Answer: 6.07 m/s

Solve for your acceleration using the formula: **A=** $\frac{V_f - V_i}{T}$

$$\frac{17.18 - 0}{2.76} =$$

Answer: 6.22

Part C: Energy

Pick the member of your group with the largest change of acceleration. They will be your vaulter this student is Student m.

Now weigh that student on the scale. Their weight in pounds is 107. Convert that to kilograms using the formula **Kg=Pounds/2.205.**

Student m's weight in Kilograms is 45.5.

Force of Gravity

Calculate the force of gravity on your vaulter on the Earth's surface using $\mathbf{F_g = ma_g}$
(Use 9.8m/s² for acceleration of gravity)

45.5 x 9.8

Answer: 445.9

Now determine just the force of the run (not including friction and resistance) Assuming the vaulter runs the same speed each time, use your answers from before to find the force created from the run using the formula $\mathbf{F_{NET} = ma}$

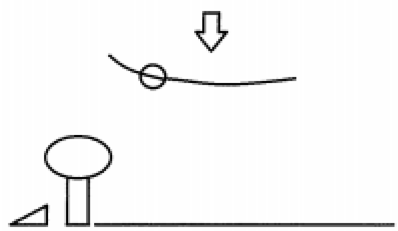
45.5 · 6.22 =

Answer: 283.01

Now have your vaulter do a front handspring and record the vault on the Coach my video app. Go through the vault in slow motion and record the following.

1.the distance the board's springs compressed when jumped on was .07 meters.

2.The max height of the vaulter (height is taken from the vaulters center) was 1.75 meters.



Starting from the beginning, were going to work through the force and energy flow of the whole vault starting with the run. Find the Kinetic Energy of the vaulter's run using the formula

KE= 1/2mv²

$$\frac{45.5 \times 6.07}{2} =$$

Answer: 138.1

Make predictions! When the vaulter hits the board the springs compress and now have energy because of their position what do you think the Kinetic energy will transfer to? (Be specific!)

Elastic potential energy

When the gymnast hits the spring board, the Kinetic Energy becomes Elastic Potential Energy due to the position of the compressed springs. Assume none of the kinetic energy is lost from friction or air resistance in the transfer. Find the spring constant of the board (solve for k) Using the formula **$PE_{Elastic}$=½ kx²** (x= the distance that the springs compress or stretch)

$\frac{138.1}{.5} = .5K \cdot .07^2$

$.0049$

Answer: 56,367.35

Make Predictions! After the vaulter jumps of the board and there is no more energy stored due to the position of the springs what do you think the energy will transfer to next?

Kinetic

The energy is then transferred back to Kinetic Energy when the vaulter jumps off the spring board. The vaulters body shapes as well as the angle at which they hit the board and then the angle they hit table and consequently propel off at effects the angular momentum of the vaulter and the height of the vaulter's after-flight (after flight is the vault phase between when the vaulter's hands are off of table until their feet reach the mat).

At the highest point of their after-flight calculate the vaulter's potential energy due to gravity using the formula **$PE_{gravity}$=ma_gh**

$= 45.5 \cdot 6.22 \cdot 1.75$

Answer: 495.27

Lastly calculate the efficiency of the after-flight of the vault by using the Initial Kinetic Energy for E_{in} and the Final Potential Energy for E_{out} using the formula **Efficiency= $\frac{E_{out}}{E_{in}}$ × 100%**

$\frac{138.1}{495.5} \times 1$

Answer: 0.28

Part D: 3-2-1

What are 3 Things you learned from this lesson? (Put a Star next to your favorite)

1. What potential energy is.
2. What kinetic energy is.
3. ★ Newton's 3 laws of motion

What are 2 Things you still have questions about? (Put a Star next to your favorite)

1. ★ Acceleration
2. Velocity

What is 1 way to apply what you learned in real life?

1. Gymnastics/Sports

Now, Take the question you still have with the star and find the answer by more experimentation or research.

What did you do to find the answer?

Take longer strides

What did you find out about your question?

If you take longer strides you have a higher velocity.

F Parent Consent and Image Release Form

Parent/ Guardian Consent Form

Title of Study: Teaching Science Through Sports

Principal Investigator:
Student: Alexis Ropchock
College of Education
University of Akron

Sponsor: Karen Plaster
College of Education
University of Akron

Introduction

Your student is being invited to participate in a research project that will be conducted by Alexis Ropchock a Williams Honors College and LeBron James Family Foundation College of Education student. This is a parental permission form for research participation. It contains important information about this study and what to expect if you permit your student to participate. Your child's participation is voluntary. Please consider the information and if you permit your student to participate you will be asked to sign this form and will receive a copy of the form for your records.

Purpose

The purpose of this study is to determine if active learning is more impactful on students understanding of science concepts.

Procedures

1. Your student will take a short pre-quiz that will be used to assess their knowledge of physical science

2. Then the students will use sports to understand new concepts such as momentum, acceleration, forces and motion. For this activity we will use the sport of gymnastics and the vault apparatus to understand momentum and dynamics. The students will work in groups to time each other's runs down the runway in order to solve acceleration questions, jump on the board to learn about Newtons Laws and forces as well as make a Potential V. Kinetic Energy graph of a vault to understand energy and forces

3. At the end of the activity your student will complete a quiz about what they learned and a survey about their experience learning this way as compared to prior experiences.

Exclusion

If your student has a medical condition or prior injury that would prevent them from running and being active, then the student should not participate in this study and will not be allowed to by the researcher.

Right to Refuse of Withdrawal

This study is completely voluntary, and you can refuse to have your child participate in it, as well as have them stop at any point with no penalty to them or you as their guardian.

Participation

By having your student participate in this study both you and the student understand and are consenting to the risks of participating in physical activity. While the activities will be completed in a safe and monitored gym, by agreeing to participate in this study you are also agreeing that you understand the risk that physical activity could result in injury.

Confidentiality

All data and quiz/survey results will be collected and stored in a safe location for the duration of the project. Only the researchers will review answers and have access to the data. Your student will not be individually identified in any publication or presentation of the research results. Only aggregate data will be used, and answers will not be linked to names of students.

Image Consent

Images and pictures of the investigation and activity will be taken for reference and explanatory purposes throughout this research project by the students and investigator. These images will be used in the final publication of this project. It is your choice to consent to the researcher using your child's image. While pictures of you will be included in the final project names will not be. You can still choose to participate in the project but choose to not give image consent in which case any pictures with your student involved in them will not be used.

Questions

You can ask questions or voice thoughts/concerns any time by calling [redacted] or emailing me at [redacted]

This project has been reviewed and approved by The University of Akron committee for protection of human subjects. If you have any questions about your rights as a research participant, you may call the committee at: 330-972-7666.

Acceptance and Signature

I have read the information provided above and all of my questions have been answered. I voluntarily agree to the participation of my child in this study. I will receive a copy of this consent form for my information.

☐ I agree to have my student's image released

☐ I do NOT agree to have my student's image released

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Student Name

____

Parent/ Guardian Printed Name

____

Parent/Guardian Signature

____

Date