Transformation 2013 Design Challenge Planning Form Guide

Design Challenge Title: Evidence: Running Stride verses Walking Stride

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School: San Marcos High School

Subject: A P Statistics

Abstract: Students will employ one-sample *t* procedures to construct a confidence interval for the mean difference between a person's walking stride and running stride.

MEETING THE NEEDS
OF STEM EDUCATION
THROUGH DESIGN CHALLENGES

REGION XIII EDUCATION SERVICE CENTER
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Step 1: Begin with the End in Mind

Section 1
Summarize the theme or "big ideas" for this design challenge.

What are the essential ideas, essential questions, major concepts that students should take away from this experience?

Students will use statistical concepts to collect data, formulate hypotheses, evaluate conditions, use one-sample t procedures to determine a confidence interval (or t statistic), and then effectively present their conclusions based on the context of the situation so that all individuals involved would comprehend the results of their findings: "How confidently can one predict a person's running stride from his/her walking stride?"

Section 2
Identify the TEKS/SEs that students will learn in the design challenge (two or three).

What are the targeted TEKS student expectations (planned)?

I. A. Constructing and interpreting graphical displays of distributions of univariate data.
I. B. Summarizing distributions of univariate data: 1. Measuring center and 2. Measuring spread.
II. C. Planning and conducting experiments: 1. Characteristics of a well-designed and well-conducted experiment; 5. Randomized block design, including matched pairs design
II. D. Generalizability of results and types of conclusions that can be drawn from observational studies, experiments, and surveys
III. D. Sampling distributions: 7. t-distribution
IV. A. Estimation (point estimators and confidence intervals) 7. Confidence interval for a difference between two means (unpaired and paired)

OPTIONAL:

IV. B. Tests of significance: 5. Test for a difference between two means (unpaired and paired)

Section 3
Identify key performance indicators students will develop in this design challenge.

What are the targeted TEKS student expectations (planned)?

Develop vocabulary (matched pairs design, confidence interval, assumptions and conditions, degrees of freedom, inference procedure, conclusion in context of the problem, etc.), determine if conditions are met and describe the conditions, create and label graphs, interpret confidence interval, carry out inference test and interpret test results in the context of the problem. Investigate the *Daubert* Standard as it applies to evidence.

Section 4
Identify the 21st century skills that students will practice in this design challenge (one or two).

Critical thinking, problem solving skills, communication, collaboration, creativity and innovation.

Section 5
Identify STEM career connections and real world applications if content learned in this design challenge.

What are the elements of STEM integration that are involved in this design?
How is the integration of math, science, engineering principles, and technology achieved?
Are STEM career connections included in the design challenge?

Careers: law enforcement officer, crime scene investigator, crime scene technician, statistician, forensic scientist, prosecutor, defense attorney, education, investment broker, many types of businesses: such as sales and marketing,

Connections: All types of possible relationships and comparisons exist throughout our world, some not as obvious as others. People who learn to be innovative, creative, and use critical thinking skills are always open to all possibilities and look for connections. Thus they are able take what is present, process it, reengineer it and then expand it to probabilities.

Step 2: Craft the Design Challenge

- ***Have you posed an authentic problem or significant question that engages students and requires STEM knowledge to solve or answer?***

State the essential question or problem statement for the design challenge.

Essential question or problem statement includes the content, outcomes, and focus for inquiry for the design challenge. Capture the theme in the form of a problem or a question that cannot be easily solved or answered.

Guidelines for crafting the question – Driving Questions:
- ❒ *are provocative.*
- ❒ *are open-ended.*
- ❒ *go to the heart of a discipline or topic.*
- ❒ *are challenging.*
- ❒ *can arise from real-world dilemmas that students find interesting.*
- ❒ *are consistent with curricular standards and frameworks.*
- ❒ *may have to be drafted and re-drafted.*
- ❒ *can be created with students.*

You are part of a crime scene investigations team. You have just been called out to an aggravated sexual assault in your town. This was a very serious crime and several crime scene investigation teams have been called out. The detectives have some suspects in mind and they want you to quickly and accurately help them determine which suspect could have performed the sexual assault. Your team has been directed to examine the east side of the victim's apartment where there were found two series of footprint impressions in the ground. These footprints appeared to be approximately the same shape and size, but there were no other definite distinguishing or unique impressions or characteristics present. The two print series are along the same ground and continue for about 70 feet. Luckily they do not cross each other therefore the two footprints paths are quite evident. Upon further observation you noticed that the stride patterns for the prints are different. The set of the prints leading to the apartment are closer together like the perpetrator was perhaps walking to the apartment; while the second set of prints are wider apart like the perpetrator was running away from the apartment. You take photographs and measurements and draw your crime scene sketches, then you decide if you could formulate how to logically verify, to the satisfaction of a detective (and hopefully the jury later), that these prints came from the same perpetrator. You could use these shoe print strides as evidence to tie a suspect to the crime.

Using your knowledge of algebra, statistics, scientific principles, and your problem solving skills, you need to create a mathematical model that uses a statistical inference test or confidence interval to convince the detectives if one of their suspects could be the perpetrator. You decide that an estimation using a confidence interval would be the easiest for the detectives to understand (you can try a one-sample *t* test later if you wish to compare the results), so you set out to create the statistical model based on a pilot study you can do fairly quickly. This will enable the detectives to confidently continue to pursue a known suspect or prompt them to set about finding an unknown suspect. Time of course is of the essence, you need to bring the rapist to justice as fast as possible to ensure the safety of your city.

Since you are working in a team, it is your team's responsibility to devise a plan of operation for your model. So decide what tasks must be accomplished and who is going to do each task. All members must work together and collaborate effectively to accomplish this task so detectives can quickly apprehend the right person. Additionally once you complete your model and collect the data, they will need a written report that covers the areas needed in an AP Statistical Significance Test. Refer to your textbook for additional information regarding Statistical Significance Tests. Pay particular attention to the supporting information and conclusion you will be presenting to the detectives orally.

Remember your report needs to be accurate, well documented, and based on empirical testing so your theory or technique must be able to withstand falsifiability, refutability or testability. This means if someone wants to redo the study themselves they should get the same results. The report and presentation should also be appealing and convincing. In *Daubert*, the Supreme Court held that trial judges are the "gatekeepers" of scientific evidence. Under the *Daubert* standard, the trial judges must evaluate the evidence offered

by the expert witnesses to determine whether their testimony is both "relevant and reliable". This is a two-pronged test of admissibility which includes:

1) The relevancy of a testimony which refers to whether or not the expert's evidence "fits" the facts of the case.

2) The Supreme Court explained that in order for expert testimony to be considered reliable, the expert must have derived his or her conclusions from the scientific method. (Daubert v. Merrell Dow Pharmaceuticals, Inc. (1993) 509 U.S. 579, 589)

These are the legal requirements so you can see why this report and presentation must be properly done. So you might need to review the one-sample *t* procedures for confidence intervals and tests of significance. Make sure you know what conditions must be met for your outcomes to be useful and statistically significant.

There are several ways you can perform your "pilot" study. We shall brainstorm the possibilities that might work, so everyone come up with ideas. The presentation can be a PowerPoint, demonstration, question and answer format, video, or you may come up with some other type of presentation format in accordance with your group's talents and abilities.

Step 3: Map the Design Challenge

Look at the *major* product for the design challenge and analyze the tasks necessary to produce a high-quality product. What do students need to know and be able to do to complete the tasks successfully? How and when will they learn the necessary knowledge and skills?

Performance Indicators (Refer to Step I, Section 3)	Already Learned	Taught before the project	Taught during the project
1. Vocabulary: random, independent, study, pilot study, experiment, simulation, confidence interval, matched pair, math model, population, sample, parameters, conclusion, conditions, one-sample *t,* statistically significant, practically significant, *t* statistics, *p*-value, $\mu_{difference}$, problem context, criminal justice terminology needed for the presentation (beyond a reasonable doubt, evidence, legal, relevant, reliable, material, *Daubert* standard, and whatever other terms might be introduced)	X	X	X
2. How to perform a pilot study	X	X	X
3. How to convert the study results to a mathematical model	X	X	X
4. Work in teams to accomplish the study, write reports, and provide the formal presentation	X	X	X
5. Use *t* procedures to perform a matched pairs statistical design (confidence interval or *t* test of significance.)	X*	X	X
6. Use *t* procedures to support a confidence interval estimation for a formal presentation	X*	X	X
7. Use the results of a linear regression to support a confidence interval estimation based on alternative data evaluation (ELABORATE)	X*	X	X
8. Make logical conclusions based on the *t*-procedures and produce valid connections needed to support legal requirements for our criminal justice system		X	X

*** if used as a culminating project after the AP Exam.**

Step 4: Plan the Design Challenge 5E Lesson

TASK 1:
Enter the Design Challenge Title and TEKS/TAKS objectives for your 5E lesson in the template provided.

TASK 2:
Describe the activities that occur throughout the 5E learning cycle. Provide explicit instructions in the 5E lesson plan, such that a first year teacher can easily understand what is expected and execute the design challenge lesson. Provide discussion facilitation questions if applicable. Use the planning forms provided on the following pages to complete each section of the 5E lesson. Refer to Step 3: Map the Design Challenge to help you identify relevant activities to include in the 5E learning cycle that focus on what students need to know and be able to do to complete the design challenge

TASK 3:
Identify and define the products and artifacts for each phase of the design challenge 5E learning cycle. ***Artifacts*** *are evidence of the student's thinking.* ***Products*** *could include culminating products or products that provide checkpoints for progress through the learning cycle.* **The table below shows some examples of artifacts and products. Many additional possibilities exist. Use the planning forms provided on the following pages to complete the 5E lesson.**

ARTIFACTS	PRODUCTS
Notes	Research papers*
Journal entries	Reports*
E-mail records	Multimedia shows*
Chat records	Presentations within the school*
Records of conversations, decisions, revisions	Exhibitions outside the school*
Interviews using a structured set of questions	Proposals
Short, reflective paragraphs	Outlines
Library search record	Plans
Telephone logs	Blueprints
Purchase receipts	Drafts
Samples	Edited drafts
Minutes of meetings	Revised drafts
Discarded ideas	Models
Prototypes	Product critiques
Group process reports	Videos
	Final versions of papers
	Field guides
	Biographies
	Websites
	Flow charts
	Design Briefs

indicates culminating projects

Design Challenge Title: *Evidence: Running Stride versus Walking Stride*

TEKS/TAKS objectives: *IA,B; IIC,D; IIID; IVA,B*

Engage Activity: Identify/focus on instructional task, connect between past & present learning experiences, lay groundwork for activities (ex. Ask a question, define a problem, show a surprising event, act out a problematic situation)

The particular subject area is introduced to the students with common examples that have meaning in their lives.

Ask students if they have ever seen a TV show or movie with police officers, detectives, or crime scene investigators at a crime scene investigating a crime that has occurred. Discussions will occur.

Ask them if they believe that all the evidence the prosecutor needs to prove a certain person committed the crime is always obviously present at the crime scene. If the evidence were there "waiting to jump" into the investigator's arms, the jury would have a very easy job and trials would not last long...Remember O.J. Simpson (accused of murder), and Cobe Bryant (accused of sexual assault).

Ask the students how certain they would want 12 strangers (jury) to be before they judged them guilty of a crime, especially one as serious as murder or aggravated sexual assault, which means 20 – 99 years in prison or, in some cases, the death penalty.

In reality a jury would never be 100% sure a defendant did commit a crime. Tell them that *probable cause* is the highest level of proof needed in a criminal trial to find someone guilty of a crime. That is between a 70-90% certain (depending on who you talk to) that the defendant on trial actually committed the crime.

Crime Scene Scenario for class:

You are part of a crime scene investigations team. You have just been called out to an aggravated sexual assault in your town. This was a very serious crime and several crime scene investigation teams have been called out. The detectives have some suspects in mind and they want you to quickly and accurately help them determine which suspect could have performed the sexual assault. Your team has been directed to examine the east side of the victim's apartment where there were found two series of footprint impressions in the ground. These footprints appeared to be approximately the same shape and size, but there were no other definite distinguishing or unique impressions or characteristics present. The two print series are along the same ground and continue for about 70 feet. Luckily they do not cross each other therefore the two footprints paths are quite evident. Upon further observation you noticed that the stride patterns for the prints are different. The set of the prints leading to the apartment are closer together like the perpetrator was perhaps walking to the apartment; while the second set of prints are wider apart like the perpetrator was running away from the apartment. You take photographs and measurements and draw your crime scene sketches, then you decide if you could formulate how to logically verify, to the satisfaction of a detective (and hopefully the jury

later), that these prints came from the same perpetrator. You could use these shoe print strides as evidence to tie a suspect to the crime.

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Remember your report needs to be accurate, well documented, and based on empirical testing so your theory or technique must be able to withstand falsifiability, refutability or testability. This means if someone wants to redo the study themselves they should get the same results. The report and presentation should also be appealing and convincing. In *Daubert*, the Supreme Court held that trial judges are the "gatekeepers" of scientific evidence. Under the *Daubert* standard, the trial judges must evaluate the evidence offered by the expert witnesses to determine whether their testimony is both "relevant and reliable". This is a two-pronged test of admissibility which includes:

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2) The Supreme Court explained that in order for expert testimony to be considered reliable, the expert must have derived his or her conclusions from the scientific method. (Daubert v. Merrell Dow Pharmaceuticals, Inc. (1993) 509 U.S. 579, 589)

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PowerPoint, demonstration, question and answer format, video, or you may come up with some other type of presentation format in accordance with your group's talents and abilities.

Engage Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Have the students work in groups of three or four to brainstorm further on how to collect their data (see below) and how they would inform the detectives, the prosecutor, and the jury if the case goes to trial, (proper documentation is a must for all legal proceedings). A well annotated table would suffice for their data collection, (example is below) but as the investigation progresses a presentation to the detectives, etc., will require a formal report and a well organized presentation (see below). They need to be aware of this from the beginning.

You might have to work with the students to help them discuss the theory of what is required to simulate a "criminal" making walking and running strides such as wetting a person's shoes and have them walk normally and measure their strides for 70 feet and do the same for the running stride. They will need to decide where to measure: toe, heel, or middle of foot, etc. so they can have consistent measurements. Since this is matched pairs it involves a difference of the means, and students will be taking an average of both their stride measurement series (walking and running). The students might come up with other plausible ways to do it too – always be open to new ideas. Please emphasize they need **accurate** measurements of both walking and running strides, and the person doing the strides must portray his/her role authentically. They also need at least ten (15 is better) people to provide data (stride measurement differences) to have an adequate pilot study.

They need to take very good **notes** of what they do because they will also have to provide a well organized, professionally done (English language used appropriately, punctuation done correctly, grammar and spelling done correctly, etc.), written (typed) report of the pilot study and its results so that the detectives will know how the study was performed in case they go to trial and the prosecutor and defense attorneys want more details. A formal, oral group presentation will be presented during the Evaluate phase.

Artifact: Student groups will turn in a short, concise, but complete narrative description of their plan of action and how they plan to gather the data (keeping statistical concepts in mind such as randomness and independent samples) so you know they are ready to start collecting their data.

Example of Table needed for data collection:

Subject	*Walking (inches)*	*Running (inches)*	*Difference*
1			
2			
3			
4 etc…			

Engage Activity Materials/Equipment

TI-83 calculator (calculator that does statistics), writing paper, writing utensils, a measuring tape, suitable area or tables for the students to get into their brainstorming groups and plan how they will do the explore activity. (See Explore Activity Materials/Equipment for possible items that can be used to do the actual walk/run activity, but your students may come up with different methods.) Also needed is a 70 plus feet walk/run area so students can visualize what is needed for planning.

Engage Activity Resources

Resources: ELA TAKS standards http://www.tea.state.tx.us/student.assessment/; http://www.fbi.gov/hq/td/academy/academy.htm or any law enforcement training or investigations unit; http://www.crime-scene-investigator.net/csi-articles.html; Any accepted Statistics and Probability Textbook that discusses observation studies and experiments such as the: The Practice of Statistics, 2nd Edition, Daniel Yates, David Moore and Daren Starnes, W.H. Freeman and Company, 2003, Texas Code of Criminal Procedures - Current as of the 80th Texas Legislature (2007)

Explore Activity: Students get involved with phenomena and materials; students work in teams to explore through inquiry.

Directed laboratories are conducted so the students can experience the principles in a controlled manner. This experience is crucial to success in solving design challenges.

Have the students work in groups of three or four to perform the observational pilot study (see Engage) and document their results in an appropriate table (See Engage for an example data table). Then have them devise a plan on how to explain their findings and what they mean so they can effectively document those findings. Keep encouraging them to start planning and organizing their notes for their investigation report and presentation to the detectives. This will of course require a formal (typed) report and a well organized, convincing presentation (PowerPoint, poster board, movie, etc.) – your end product or artifact (see Evaluate).

In this part they should properly perform their observational pilot study using their subjects and complete their data collection table and notes, which will be the artifact for the Explore part (see below). The results should allow you to quickly check the accuracy of the statistical elements and ensure they are on the right track. You can hopefully direct them to the right path if they have strayed. Make sure all is done in accordance with (IAW) the statistical principles of the College Board Advanced Placement (AP) statistics course.

Remind them they need to take very good **notes** of what they did, not only because they need to provide a well organized, professionally written record/report of their investigation, but sometimes it is years between the criminal investigation and the trial. Investigators will not be able to remember all the details of cases that are delayed for several months or years.

Explore Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

The artifacts for the Explore section will be your observations of the students' pilot studies. Then also have them turn in their data collection procedure notes (how they did the study, how they measured the strides, what they told the subjects to do, ensured independence, etc.), the data table, and the sample means difference results (mean, standard deviation, number of data points). You will be able to quickly check the accuracy of these statistical elements and ensure they are on the right track.

Make sure all is done in accordance with IAW, the statistical principles of the one-sample *t* procedures and statistics course.

Explore Activity Materials/Equipment

TI-83 calculator (calculator that does statistics), writing paper, writing utensils, suitable area to walk and run 70 plus feet, black bulletin board paper or some other sturdy paper that will retain the footprints and allow accurate measuring to occur, adhesive tape, or water, powdered chalk or some other suitable residue for marking the students' footprints, broom, and measuring tape.

Explore Activity Resources

Resources:http://www.fbi.gov/hq/td/academy/academy.htm or any law enforcement training or investigations unit; http://www.crime-scene-investigator.net/csi-articles.html; http://apcentral.collegeboard.com/apc/public/repository/ap08_statistics_coursedesc.pdf; Any accepted Statistics and Probability Textbook that discusses observation studies and experiments such as the: The Practice of Statistics, 2nd Edition, Daniel Yates, David Moore and Daren Starnes, W.H. Freeman and Company, 2003, Texas Code of Criminal Procedures - Current as of the 80th Texas Legislature (2007)

Explain Activity: Students discuss observations, ideas, questions and hypotheses with peers, facilitators, groups. Learners apply labels to their experiences – thus developing common language, clarification/explanation of key concepts

Delivery of the content begins with a discussion of the principles illustrated by the Hands-On examples. In this way, the participants' intuition is tapped to introduce terms and concepts that they may have heard. This approach leads naturally to an in-depth discussion of the science and mathematics concepts underlying the particular subject area.

Now the students are ready to use the one-sample *t* procedures to see if the walking strides and running strides can be tied together and used to predict one if you have the other.

The students have collected their data and documented their collection procedures. We will assume the data is independent since one student's performance "should" not have affected

another student's performance. Though the data may not be random (SRS), if you had to use all the class members, (or perhaps you got others outside the class to provide data), hopefully you got to randomly choose who provided data and who didn't. Anyhow, if we can't assume it was an SRS we will just say that it wasn't and continue with the test anyway. You may want to explain this to the students…sometimes necessity degrades some of the statistical principles, but we will document this in our report so everyone knows the procedure and proceed on.

Now the students are ready to start working on their one-sample *t* confidence interval (or *t* statistic if you choose – the conditions will be the same). The confidence interval procedure is modeled below but the significance test would be very similar.

I'll use the four step AP statistics reporting format to ensure I don't leave anything out that is required on the AP Statistic Free Response portion of the AP Exam. Students should use this format, too.

Step 1: *Identify the population of interest and the parameter you want to draw conclusions about*: The population of interest is criminal offenders who commit aggravated sexual assault who walk to a crime scene and run away from the crime scene after committing the assault. We want to estimate the mean difference $\mu_{Diff} = \mu_{walking} - \mu_{running}$ before and after the assault occurred if all individuals in the population walked to and ran from the assault. (You may wish to reverse the means for positive numbers is you wish, just state what you are doing.)

Step 2: *Choose the appropriate inference procedure and verify the conditions for using the selected procedure.* We will use a one-sample, *t* procedures to construct a confidence interval for μ_{Diff} since the population standard deviation of the differences in those walking to and running from an assault is unknown. We will check the conditions:
1) Data came from an SRS from the population of interest (see above - if data were not random then state it, and document later in your report that your study could not assure randomness).
2) We will assume the population of criminals who commit aggravated sexual assault is symmetrically shaped (normal is not a good word for this here), though there has been no previous documentation, this is a pilot study after all. We shall have to do a univariate graph (boxplot, histogram, stem plot, etc.) for our sample data to see if there are any outliers or departures from normality.
NOTE: Even if it is not normal we shall continue the confidence interval procedures anyway and document this fact in the report.

Step 3: *If the conditions are *met, carry out the inference procedure.*
We should use a *t* critical value for 90% at a minimum; you can use higher if desired, but since this is the upper level of proof for "Beyond a Reasonable Doubt" this is realistic. Each group's result will depend on their data but all will use the formula for a *t* procedure confidence interval:

$\overline{x}_{Diff} \pm t^* \frac{s_{Diff}}{\sqrt{n}}$. Of course the *t* critical value (*t**) you choose will depend on your degrees of freedom.

Step 4: *Interpret your results in the context of the problem*. We are 90% confident that the actual mean difference between walking and running distances for the population of sexual assault offenders is (_____,_____) inches.

This study does/does not (depending of your results,) provide evidence that given the walking stride, the running stride of sexual assault offenders can be predicted and vice versa.

Ask students: After having done the confidence interval estimation using their data, do they think their evidence could meet the *Daubert* Standard at trial?

Be sure and tell them the above will be incorporated into their formal report/presentation for the detectives and prosecutor. This is the main portion of the presentation along with the description of how they accomplished the data collection. Of course making the presentation appealing and convincing is also a challenge they must meet.

Explain Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

The artifacts for this section will be turning in a finished draft of the report (they would normally be giving the detectives and prosecutor), which contains the four step, matched pairs *t* procedure as modeled in the Explain phase above, along with their data table and explanation of how they performed the data collection (this should just have to be a finished product of what they turned in during the Explore phase). The students should demonstrate their understanding of the concepts and the data collection procedures IAW the AP Statistical guidelines needed to be successful on the AP Statistics Exam. Their presentation (Evaluate phase) will also have to discuss the validity, relevance, and reliability of the confidence interval and its use in generalizing their findings to the population of sexual assault offenders.

Explain Activity Materials/Equipment

Materials/Equipment: TI-83 calculator, paper, rulers, writing utensils, computer to create the final report. Optional: Statistical software such as Minitab, Fathom, Excel and etc. can be used to display the data in graphical form and be integrated into a Microsoft document.

Explain Activity Resources

ELA TAKS standards http://www.tea.state.tx.us/student.assessment/; http://www.fbi.gov/hq/td/academy/academy.htm or any law enforcement training or investigations unit; http://www.crime-scene-investigator.net/csi-articles.html; http://apcentral.collegeboard.com/apc/public/repository/ap08_statistics_coursedesc.pdf; Any accepted Statistics and Probability Textbook that discusses observation studies and experiments such as the: The Practice of Statistics, 2nd Edition, Daniel Yates, David Moore and Daren Starnes, W.H. Freeman and Company, 2003, Texas Code of Criminal Procedures - Current as of the 80th Texas Legislature (2007)

Elaborate Activity: Expand on concepts learned, make connections to other related concepts, apply understandings to the world. (ex. Extend & apply knowledge).

At its heart, engineering is the application of science and mathematics to design solutions to problems for humanity. Thus, providing design opportunities to students is a key component of STEM education.

Opportunities to be creative in open-ended situations peak the interest of many students, providing an answer to the ubiquitous question: "Why do we need to know this?"

Mike Baxter and Robert Lawrence, D. C. Everest Jr. High, Schofield WI. 54476, (mbaxter@dce.k12.wi.us) have developed an activity entitled "Dino Long Legs: The Relationship between Stride Length and Leg Length".

They said paleontologists use the ratio of stride length divided by leg length (SL/LL) to tell whether a dinosaur is walking, trotting, or running. They said that paleontologists use the following values to determine how a dinosaur might have been moving.

Less than 2 walking
2 to 2.9 trotting
Greater than 2.9 running

Have the students compare their findings for five or more of their test subjects and see what the ratios are for them when walking and running based on their leg length. They can determine the subjects' leg lengths by measuring the length of their legs from the hip joint to the base of the heel. The students can then compare their subjects' *mean* walking stride and *mean* running stride (from the data they collected earlier) based on their leg lengths. If this is valid for our subjects, we may be able apply these principles to our suspect and that will support our case once we have a suspect in custody; remember, the more evidence you have tying a suspect to a crime, the stronger the case and the more likely the conviction. You could also expand this to the entire class and have them measure their legs and examine this data for the ratio of stride length to leg length to see if the values would apply to all people and see if we could generalize this to our population of high school students.

Students should make a bivariate graph (scatter plot) and see what that relationship is of stride length and leg length. It should be linear, thus they can do a linear regression *t* test using their measured leg lengths verses walking strides and running strides. Additionally they can compose a four step *t* procedures using the linear *t* regression and write a brief summary of their findings.

By the way according to Baxter and Lawrence, your sample data for walking should show that children and adults have a *stride length* to *leg length* ratio of less than two. Running ratios should be greater than 2.9. (Also if anyone asks, the direct relationship between height and leg length is about 2.0:1.)

Additionally, discuss what statistical inference and generalization are again and ask them if we can make inferences and generalize our data to the population of sexual assault offenders?

Statistical inference allows us the use of statistical methods to draw conclusions about a population from our sample data.

Generalization is when I can take my inference results for my sample data and generalize or correctly apply the results to other groups not just my population or sample.

You can ask the students if they think the results of a test like this would meet the *Daubert* Standard in court.

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2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***

Once the students have measured their subjects' leg lengths and examined the ratios based on Baxter's

and Lawrence's activity above, have them compare their walking and running stride length *means* data to Baxter's and Lawrence's ratio information.

Have them demonstrate the link between the two measurements (ours verses Baxter's and Lawrence's) results if there is one. This can be done on paper by having them graph their bivariate data (the five or more measurements they made), leg length verses stride length (put both walking and running on the same graph using different colors), and discuss their scatterplots. Then you can again discuss if they think the results of this test would meet the *Daubert* Standard.

Additionally you can have half the groups perform the 4 step linear regression *t* test using their data on the leg length verses walking strides and the other half do the same thing using the leg lengths verses the running strides. Have them provide their observations concerning the comparisons and the feasibility of the linkage between the three measurement methods.

Discuss whether or not we can generalize our data to the population of sexual assault offenders. Why or why not?

Elaborate Activity Materials/Equipment

Materials/Equipment: TI-83 calculator, paper, writing utensils, markers/map pencils, computer to create the final report, measuring tape; Optional: Statistical software such as Minitab, Fathom, Excel and etc., can be used to display the data in graphical form.

Elaborate Activity Resources

Resources: *http://www.geology.wisc.edu/~museum/hughes/DinoLongLegs.html*
Any accepted Statistics and Probability Textbook that discusses observation studies and experiments such as the: The Practice of Statistics, 2nd Edition, Daniel Yates, David Moore and Daren Starnes, W.H. Freeman and Company, 2003, Texas Code of Criminal Procedures - Current as of the 80th Texas Legislature (2007)

Evaluate Activity: Ongoing diagnostic process to determine if the learner has attained understanding of concepts & knowledge (ex. Rubrics, teacher observation with checklist, student interviews, portfolios, project products, problem-based learning products, assessments). Leads to opportunities for enrichment through further inquiry and investigation.

What is the culminating task?

The rubric for the activity should be given to the students when the activity is introduced so they will know the expectations.

Rubric is an attachment. See below for the expectation.

Evaluate Activity Products and Artifacts:

1. ***Artifacts (KWL charts, journal entries, etc) are evidence of the student's thinking.***
2. ***Products (flow charts, data tables, models, etc) include checkpoints for progress through a design challenge.***
3. ***What is the final product (working model, portfolio, presentation, etc) you will require?***

See rubric attachment.

Have the students present their oral, formal, group presentations to the class (PowerPoint, poster and discussion, question and answer, movie, etc. as approved by the teacher).

They will get evaluated based on the rubric - Evidence: Running Stride verses Walking Stride.

Evaluate Activity Materials/Equipment

Materials/Equipment: TI-83 calculator presenter, writing utensils, markers/map pencils, white board, computer, overhead projector or students provide their on presentation materials as desired. Optional: Statistical software such as Minitab, Fathom, Excel and etc., can be used to display the data in graphical form.

Evaluate Activity Resources

Resources: **http://rubistar.4teachers.org/index.php**, Texas Code of Criminal Procedures, (2007) http://apcentral.collegeboard.com/apc/public/repository/ap08_statistics_coursedesc.pdf; Any accepted Statistics and Probability Textbook that discusses observation studies and experiments such as the: The Practice of Statistics, 2nd Edition, Daniel Yates, David Moore and Daren Starnes, W.H. Freeman and Company, 2003.

Step 5: Plan the Assessment

State the criteria for exemplary performance for each artifact/product of each section of the 5E lesson.

- ***Do the products and criteria align with the standards and outcomes for the design challenge?***

Engage Artifact(s)/Product(s): Written "Plan" of how students will conduct their pilot study.
Explore Artifact(s)/Product(s): Observation of students as they conduct the pilot study, data table, and statistics and data collection procedures.
Explain Artifact(s)/Product(s): Finished draft (including the four step *t* procedures).
Elaborate Artifact(s)/Product(s): Bivariate data graph and linear regression *t* (four-step) procedures summary report.
Evaluate Artifact(s)/Product(s): Presentation: four-step procedures, data collection procedures, and feasibility of pilot study as valid evidence.

Step 6: Create Rubrics

Develop rubrics for each artifact/product of the 5E learning cycle, using the criteria for exemplary performance as a foundation for the rubric.

- ***Do the artifacts/ products and criteria align with the standards and outcomes for the design challenge?***

Use rubrics to demonstrate your expectations for students or create a rubric with students to determine the elements of exemplary performance.

Effective rubrics:

- ❒ *are based on an analysis of student work.*
- ❒ *target the central features of performance*
- ❒ *provide useful feedback to students*
- ❒ *use descriptors that students are able to use to self-assess or self-correct*
- ❒ *provide indicators with examples to demonstrate levels of performance*

Rubric Resources:

http://rubistar.4teachers.org/index.php
http://www.rcampus.com/indexrubric.cfm
http://school.discovery.com/schrockguide/assess.html#rubrics
http://www.uwstout.edu/soe/profdev/rubrics.shtml
Math Problem Solving Rubric

Rubric: Evidence: Running Stride verses Walking Stride

Student Names: _____ Date: _____Period: ___

CATEGORY	4	3	2	1
Mathematical Concepts	Explanation shows complete understanding of the mathematical concepts used to solve the problem(s).	Explanation shows substantial understanding of the mathematical concepts used to solve the problem(s).	Explanation shows some understanding of the mathematical concepts needed to solve the problem(s).	Explanation shows very limited understanding of the underlying concepts needed to solve the problem(s) OR is not written.
Strategy/Procedures	Typically, uses an efficient and effective strategy to solve the problem(s).	Typically, uses an effective strategy to solve the problem(s).	Sometimes uses an effective strategy to solve problems, but does not do it consistently.	Rarely uses an effective strategy to solve problems.
Explanation	Explanation is detailed and clear.	Explanation is clear.	Explanation is a little difficult to understand, but includes critical components.	Explanation is difficult to understand and is missing several components OR was not included.
Legal Standards	Understands and accomplishes all legal standards	Understands and accomplishes most legal standards	Doesn't understand the legal standards but does attempt to accomplish the legal standards	Doesn't understand and does not accomplish the legal standards
Neatness and Organization	The work is presented in a neat, clear, organized fashion that is easy to read.	The work is presented in a neat and organized fashion that is usually easy to read.	The work is presented in an organized fashion but may be hard to read at times.	The work appears sloppy and unorganized. It is hard to know what information goes together.
Presentation	Presentation addressed legal standards, was accurate and convincing, and very appealing	Presentation addressed legal standards, was accurate and convincing, but was lacking in appeal	Presentation addressed legal standards, was not entirely accurate and convincing, but was appealing	Presentation didn't address legal standards, was not entirely accurate and convincing, and lacked appeal

Date Created: **Jun 26, 2008** **Grading Legend: 24 – 19 = A; 18 – 13 = B; 12 - 7 = C; 6 and below = F**