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| **TEXAS CTE LESSON PLAN**[www.txcte.org](http://www.txcte.org) |
| **Lesson Identification and TEKS Addressed** |
| **Career Cluster** | Law, Public Safety, Corrections & Security |
| **Course Name** | Forensic Science |
| **Lesson/Unit Title** | Unit I Understanding the Scientific Method |
| **TEKS Student Expectations** | **130.339. (c) Knowledge and Skills**(3)The student uses scientific methods and equipment during laboratory and field investigations. (A) The student is expected to know the definition of science and understand that it has limitations, as specified in subsection (b)(4) of this section(3) The student uses scientific methods and equipment during laboratory and field investigations. (B) The student is expected to know that scientific hypotheses are tentative and testable statements that must be capable of being supported or not supported by observational evidence. Hypotheses of durable explanatory power that have been tested over a wide variety of conditions are incorporated into theories(3) The student uses scientific methods and equipment during laboratory and field investigations. (D) The student is expected to distinguish between scientific hypotheses and scientific theories |
| **Basic Direct Teach Lesson**(Includes Special Education Modifications/Accommodations and one English Language Proficiency Standards (ELPS) Strategy) |
| **Instructional Objectives** | 1. Define science and the scientific method. 2. Differentiate between scientific hypotheses and scientific theories. 3. Explain how the scientific method is used to answer questions and solve cases in forensics. 4. Use the scientific method to solve an investigation, including all the steps of the method and an experiment. |
| **Rationale** | Forensics is an actual application of science and technology to solve crimes in the criminal justice system. Since forensics employs a vast number of scientific fields, knowing the strengths and limitations of scientific theories and hypotheses, and understanding the scientific method is crucial to using science to its full potential in the pursuit of justice. |
| **Duration of Lesson** | 5 hours total − 1 hr. lecture − 3 hrs. activities − 1 hr. quizzes and exam |
| **Word Wall/Key Vocabulary***(ELPS c1a,c,f; c2b; c3a,b,d; c4c; c5b) PDAS II(5)* |  |
| **Materials/Specialized Equipment Needed** | * Scientific Method Exam
* Scientific Method Quiz
* Choosing the Right Equipment Worksheet Key
* Purchase Power Checklist
* Scientific Method Crossword Puzzle Key
* Discussion Rubric
* Presentation Rubric
* Research Rubric
* Materials
* Choosing the Right Equipment Worksheet and Key
* Designing Experiments Handout and Key
* Purchase Power Handout and Checklist
* Scientific Method Crossword Puzzle and Key
* Expanding to Real Life Handout
* Laser projector
* Computer
* Worksheets
* Computer Lab or Internet Sources
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| **Anticipatory Set**(May include pre-assessment for prior knowledge) |  |
| **Direct Instruction \*** | I. Science – modern science tries to understand and explain how the natural world works now and how it got to be that way A. Facts about science 1. The study of natural phenomena 2. Studies what can be observed, measured, and tested by scientific methods 3. We must use our senses to observe and evaluate 4. Based on the assumption that the universe is orderly, reasonable, and testable 5. Used to predict natural events that may occur 6. Based on physical, mathematical, and conceptual models 7. Classified into many different fields, topics, or categories for specialized study 8. The different fields overlap and depend on each other for further knowledge and explanations 9. A vast body of knowledge that is always changing and expanding, but is does have limitations 10. Objective, unbiased, and impartial—or it should be B. Myths about science 1. A rigid collection of facts that are inflexible 2. Able to explain the answer to every question (some phenomena are not scientifically testable) 3. Unorganized, unrelated, or untestable 4. Based on that which cannot be observed or measured, or that which is outside of our senses to be perceived 5. Only based on one disciple, field, or topic of knowledge 6. Subjective, biased, or partial (it should not be) C. Scientific Explanations – Hypothesis, Theory, or Law 1. Hypothesis – an educated guess based on observation a) Can be given as an explanation for the occurrence of an event or a presumption to guide an investigation b) Should be based on some knowledge or research c) Must try to answer a scientific question d) Must be testable by known scientific methods e) Can be supported or refuted through further observation or experimentation f) Can be proven wrong; it doesn’t have to be right (1) A wrong hypothesis only leads to another hypothesis (2) A better product, a better clue, a better suspect g) Should be stated in such a way that the experiment will collect measureable/quantifiable data if possible 2. Theory – summarizes a hypothesis or group of hypotheses that have been supported with repeated testing over a wide variety of conditions over time a) Are valid as long as no evidence disputes them b) Are well-established and highly reliable c) Can be used as principles of explanation and prediction for a group of phenomena d) Can be disproven, modified, or changed with new scientific knowledge, observations, and technology 3. Law – generalizes a body of observations that can be used to describe or predict something universally understood in nature a) At the time that it is made, no exceptions can have ever been found in a law b) Laws never explain “why” something happens, only that it will always happen the same way with no exceptions c) Example – Newton’s Law of Gravity could be used to predict the behavior of a dropped object, but it could not explain why it happened d) Theories explain “why” something happens; laws predict that it will always happen the same way D. Six Criteria of Science: CONPTT 1. Consistent – results are based on repeatable observations and/or explanations 2. Observable – limited to the basic human senses or extensions of the senses (microscopes, computers, etc.) 3. Natural – a natural cause must be used to explain why or how; supernatural explanations are not allowed 4. Predictable – the result or observation can be used to make predictions about natural events 5. Testable – the natural cause of the event must be testable through the process of science and/or controlled experiments 6. Tentative – theories are subject to revision and correction, even to the point that the entire theory might be proven wrong E. Non-Science – an area of science that does not meet the criteria of science 1. Such areas may be very logical and based on good reasoning, but do not fall into the true realm of science 2. Examples: a belief system (religious), philosophy, personal opinion, ethic, or sense of aesthetics II. Scientific Method – the established method of research and discovery. It follows an eight-step process to collect and evaluate information, and maintain objectivity when arriving at the conclusion. It is used to solve every case in the criminal justice system A. General Steps of the Scientific Method 1. Asking or defining a question – start with a question that can be tested a) The question should be specific b) It can be based on observations c) Information is normally gathered before the final question is decided 2. Researching the question or problem – books, journal articles, manuals, magazines, newspapers, the internet, etc. are used in the research a) The hypothesis may have been already studied or researched (there may already be an answer) b) Research sources used should be scientific, objective, and unbiased 3. Forming a hypothesis – the answer to the question is given in the form of an educated guess of what is expected to happen or the answer a) The hypothesis must be in the form of a statement b) The hypothesis must be researched before it’s stated (that is why it is an educated guess) c) The hypothesis must be testable; if it is not, it is not a valid hypothesis d) The hypothesis must allow for a variable to be tested and what results are expected e) Should be given in this format: “If this\_\_\_\_\_\_\_\_ is done/changed, then this\_\_\_\_\_\_\_ will happen/be observed” f) Null hypothesis – what the researcher is seeking to not have happen, to disprove, or to nullify (sometimes given in addition to the hypothesis) (1) The opposite of the hypothesis 4. Developing and performing the experiment a) Must test the hypothesis b) Should have planned steps for implementation c) Should only have one variable that is tested d) Either supports or disproves the hypothesis e) The experiment will be retested to validate the results 5. Collecting the data – a lab notebook is kept through all of the steps of the scientific method a) All observations that led to the question should be recorded, as should the research that was done, the formation of the hypothesis, and any hypotheses that were not used b) Write down how the experiment was designed and all its steps) All the details, data, and measurements of the experiment are documented (1) Document every detail (2) Write down any mistakes or changes (3) Leave nothing out d) Clearly labeled tables are normally used to document data, especially changes over time (this makes graphing data easier later) 6. Analyzing the data – data collected is scrutinized a) Information is compared and contrasted b) Graphs, tables, and charts are used to visually review the data c) Averages, means, and deviations should be calculated; statistical analyses should also be performed 7. Writing the conclusion – data/results are studied to draw conclusions a) It is stated whether the results support or disprove the hypothesis (it is perfectly okay for the hypothesis to be incorrect) b) Any additional data found, or new results established that were unexpected, might need research to be explained c) All problems or sources of error should be discussed d) Results should be interpreted without any bias or prejudice, and as objectively as possible e) Any future data or experiments that are needed for further information should be considered f) The results gathered should be repeatable by others 8. Communicating the results – the results are communicated and published in written format in a scientific journal a) Lecturing, sharing, and retesting are performed b) The format used for communicating depends on the actually topic studied and the type of audience who will be reviewing/using the scientific research B. Scientific Method Intersections 1. There are many crossovers, turnarounds, and repeats in the scientific method; it is seldom that the method proceeds through all eight steps in an organized fashion 2. This is especially true in criminal investigations: research yields more knowledge that changes the hypothesis and the experiment (investigation), more data is collected that also might change the hypothesis, the exploration changes, results are not expected, conclusions can change, and the process may begin again C. Experiments 1. Experimental design – the experiment should be well-designed and meet certain criteria a) The experiment should be based on the research that was done in forming the question and the hypothesis b) All steps and conditions for the experiment should be planned and detailed c) Steps should be recorded before the experiment, and a record made of any changes made during or after the experiment d) The experiment should be designed, carried out, and recorded in such a way that further investigators can repeat the procedure (and hopefully get the same results) e) All variables should be organized and managed f) Technology use should be planned g) Data collection should be done with extreme care and answer the following questions (1) How will data be collected? (2) Will data collection be reliable? (3) How can data be measured, and quantitative and objective? (4) Is data subject to bias in any step? (5) Will data collection be precise and accurate? h) The method of recording data collection should also be premeditated i) The experiment should be planned so that the hypothesis made is tested and the original question is answered j) The experiment should be conducted several times before results are published and communicated 2. Variable – anything that can be changed or controlled in an experiment, and/or any changes that occur because of something else that changed a) Three types of variables (1) Independent variable (a) The one factor that is changed, or the one factor that is different between the groups (b) One factor is best, so you can depend on your results, but in analyzing a criminal case all of the variables cannot always be controlled or minimized (2) Dependent variable (a) The variable that is observed to see whether it is affected by the independent variable (b) This is normally the data that is collected as the experiment progresses (c) The dependent variable depends on what was changed in the experiment, or it depends on the independent variable (3) Controlled variables (often called constants or controls) (a) Things that could change in the experiment, but should be kept constant or unchanging (b) If these change you have more than one independent variable and your data collected or results may not be valid b) Example – in an experiment comparing the fizz released from different types of soda your variables are (1) Independent variable – the type of sodas tested (this should be the only difference between the sodas) (2) Dependent variable – the amount of fizz released (3) Controlled variables (a) Same size/type of soda cans (b) Bought at the same store, with the same expiration dates (c) Kept at the same temperature, with the same amount of agitation per can (d) The same method of measuring fizz volume should be used III. Contribution of Science A. Science and the scientific method are an integral part of mankind and have been for many years B. Explaining the natural world around us is a quest that many share C. The scientific method is our way of consistently answering questions and creating new inspiration D. Scientific ideas have limitations and can evolve over time, but scientific knowledge is the most reliable knowledge we have about the natural world E. The criminal justice system has been tremendously impacted by the use of the scientific method and scientific knowledge, and science is the basis of the field of Forensics*Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*NONE |
| **Guided Practice \*** | 1. Choosing the Right Equipment. Have the students select tool(s) for the hypothesis on the Choosing the Right Equipment Worksheet. Have students discuss their answers as a class. Use the Choosing the Right Equipment Worksheet Key and/or the Discussion Rubric for assessment. 2. Bikini Bottom Experiments. Have the students complete some simple experiments. The experiments and answer keys at http://sciencespot.net/Media/scimthdexps.pdf may be used. 3. Designing Experiments. Have the students read the scenario and answer the questions on the Designing Experiments Handout. Use the Designing Experiments Key for assessment. 4. Purchase Power. Have the students select an everyday product and test it with their own experiment using the Purchase Power Handout as a guide. Use the Purchase Power Checklist for assessment.*Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*NONE |
| **Independent Practice/Laboratory Experience/Differentiated Activities \*** | *Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*NONE |
| **Lesson Closure** |  |
| **Summative/End of Lesson Assessment \***  | * Scientific Method Exam
* Scientific Method Quiz
* Choosing the Right Equipment Worksheet
* Purchase Power Checklist
* Scientific Method Crossword Puzzle

*Individualized Education Plan (IEP) for all special education students must be followed. Examples of accommodations may include, but are not limited to:*For reinforcement, have students practice vocabulary by completing the Scientific Method Crossword Puzzle. Use the Scientific Method Crossword Puzzle Key for assessment. |
| **References/Resources/****Teacher Preparation** | * Saferstein, Richard. Forensic Science: An Introduction. New Jersey: Pearson Prentice Hall, 2008.
* Bertino, Anthony J. Forensic Science: Fundamentals & Investigations. Mason, OH: South-Western Cengage Learning, 2009.
* Deslich, Barbara; Funkhouse, John. Forensic Science for High School Dubuque, Iowa: Kendall/Hunt Publishing Company, 2006.
* http://sciencespot.net/Media/scimthdexps.pdf
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| **Additional Required Components** |
| **English Language Proficiency Standards (ELPS) Strategies** |  |
| **College and Career Readiness Connection[[1]](#footnote-1)** |  |
| **Recommended Strategies** |
| **Reading Strategies** |  |
| **Quotes** |  |
| **Multimedia/Visual Strategy****Presentation Slides + One Additional Technology Connection** |  |
| **Graphic Organizers/Handout** |  |
| **Writing Strategies****Journal Entries + 1 Additional Writing Strategy** |  |
| **Communication****90 Second Speech Topics** |  |
| **Other Essential Lesson Components** |
| **Enrichment Activity**(e.g., homework assignment) | For enrichment, have students research, summarize, and present an article related to science. Use the Expanding to Real Life Handout for the activity, and the Research Rubric and Presentation Rubric for assessment. |
| **Family/Community Connection** |  |
| **CTSO connection(s)** | SkillsUSA |
| **Service Learning Projects** |  |
| **Lesson Notes** |  |

1. Visit the Texas College and Career Readiness Standards at <http://www.thecb.state.tx.us/collegereadiness/CRS.pdf>, Texas Higher Education Coordinating Board (THECB), 2009. [↑](#footnote-ref-1)