Tennessee CTE

# STEM II: Applications

## The Roles of Scientists and Engineers

### Science Path

1 Determine the scientist's role in explaining why phenomena occur in the natural world, justified by historical and current science knowledge. Research a known scientist and present in an informative paper, oral presentation, or other format his/her contributions to scientific knowledge. Include an outline of how the scientific inquiry process was used in his/her work. 1

### Engineering Path

2 Determine the engineer's role in developing solutions to design problems that are justified by scientific knowledge. Research a known engineer and present in an informative paper, oral presentation, or other format his/her designs and explain how they influenced technology in his/her field. Include an outline of how the design process was used in his/her work. 2

## Questioning and Defining Problems

### Science Path

3 Engage in scientific inquiry by brainstorming for questions to understand how a certain phenomenon in the natural world works, to understand why a phenomenon occurs, or to determine the validity of a theory. 3

4 Research various sources (e.g., articles, end-uses, textbooks) and identify one or more questions that will guide a scientific investigation. For example, questions should be relevant, testable, and based on current scientific knowledge. 4

5 Develop an original proposal as would a natural or social scientist that will guide the scientific inquiry and follow responsible ethical practices. For example, the proposal should outline the reason for the research interest, hypothesis, methodology, data analysis, importance of study, and deliverables. 5

### Engineering Path

6 Ask clear, relevant questions that lead to defining a design problem. For example, questions should be testable and explore the requirements of a problem solution, but not define the methodology to solve the problem. 6

7 Brainstorm for several problem solutions, then conduct research using various sources (e.g., articles, end-uses, textbooks) to generate more solution ideas. Justify ideas using evidence from the sources. 7

8 Develop a design brief that will guide a design process and follow responsible ethical practices. For example, the design brief should outline a problem definition, design statement, criteria, constraints, and deliverables. 8

## Modeling

### Science Path

9 Create models to illustrate questions and represent processes or systems that are justified by scientific evidence. For example, models can be diagrams, drawings, or scaled down physical representations. 9

10 Use mathematics and technology to develop multiple models to predict an occurrence in the natural world. Compare and contrast the recorded observations from each model. For example, computer modeling can be used to analyze current atmospheric conditions to predict the weather in days ahead. 10

11 Analyze results from modeling and appropriately determine when it is necessary to revise questions. Justify revisions with evidence. 11

### Engineering Path

12 Create models to illustrate design criteria and represent processes, mechanisms, or systems. For example, models can be drawings, mathematical representations, or computer simulations. 12

13 Identify and sketch at least three alternative solutions, to a problem, that consider analyses such as mechanical and electrical systems. For example, computer modeling can be used to analyze the effect of stress and strain on a beam. 13

14 Conduct iterations of modeling a solution to a design problem, demonstrate that design criteria are met, and select a reliable design approach. 14

## Planning & Investigating

### Science Path

15 Make a hypothesis that explains a scientific question, plan and conduct a simple investigation, and record observations (e.g., data) in a manner easily retrievable by others. 15

16 Identify the independent variables and dependent variables in an investigation. Demonstrate the effects of a changing independent variable on a dependent variable, and observe and record results. 16

### Engineering Path

17 Develop a design proposal to create prototypes for testing. The proposal should provide details such as drawings with dimensions, materials, and construction process. 17

18 Outline testing procedures that identify type of data (e.g., number of trials, cost, risk, and time) that is needed to produce reliable measurements and the specifications (e.g., effectiveness, efficiency, and durability) to determine whether a design has exceeded or failed expectations. 18

| | | |
|---|---|---|
| **Data Analysis & Interpretation** | **Science Path** | |
| | 19 | Use mathematics to represent and solve scientific questions. For example, simple limit cases can be used to determine if a model is realistic. [19] |
| | 20 | Evaluate data and identify any limitations of data analysis. Using this information, determine whether to make scientific claims from data or revise an investigation and collect more data. [20] |
| | 21 | Compare and contrast the data results from multiple iterations of a scientific investigation. For example, consider how well each explanation is supported by evidence, prior research, and scientific knowledge. [21] |
| | **Engineering Path** | |
| | 22 | Use mathematics to represent and solve engineering problems. For example, simple limit cases can be used to determine if a model is realistic. [22] |
| | 23 | Evaluate data and identify any limitations of data analysis. Using this information, determine whether a design solution is optimal or should be refined and tested again. [23] |
| | 24 | Compare and contrast the data results from testing multiple design solutions. For example, consider how well each design solution meets the design criteria and constraints. [24] |
| **Problem Solutions & Scientific Explanations** | **Science Path** | |
| | 25 | Develop an explanation to a scientific question that is logically consistent, peer reviewed, and justified by data analysis and scientific knowledge. [25] |
| | **Engineering Path** | |
| | 26 | Develop an optimal design solution that is justified by data analysis and scientific knowledge, and meets ethical and design criteria and constraints. [26] |
| **Communicating Solutions & Explanations** | **Science Path** | |
| | 27 | Develop a technical report to communicate and defend a scientific explanation and justify its merit and validity with scientific information. Consider the ethical implications of the findings. The report can include tables, diagrams, graphs, procedures, and methodology. For example, conduct a STEM forum, present scientific research, and provide evidence to support arguments for or against scientific solutions. [27] |
| | **Engineering Path** | |
| | 28 | Develop a design document to communicate the final design solution and how well it meets the design criteria and constraints. For example, the design document can include charts, graphs, calculations, engineering drawings, as well as information regarding marketing, distribution, and sales. For example, conduct a STEM forum, present engineering design briefs, and provide evidence to support arguments for or against design solutions. [28] |

| Safety | Safety |
| --- | --- |
| Accurately read and interpret safety rules, including but not limited to rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply. 29 | 29 Accurately read and interpret safety rules, including but not limited to rules published by the National Science Teachers Association (NSTA), rules pertaining to electrical safety, Occupational Safety and Health Administration (OSHA) guidelines, and state and national code requirements. Be able to distinguish between the rules and explain why certain rules apply. 29 |
| Identify and explain the intended use of safety equipment available in the classroom. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment. Incorporate safety procedures and complete safety test with 100 percent accuracy. 30 | 30 Identify and explain the intended use of safety equipment available in the classroom. For example, demonstrate how to properly inspect, use, and maintain safe operating procedures with tools and equipment. Incorporate safety procedures and complete safety test with 100 percent accuracy. 30 |