8th Grade Science Research

This course is designed to guide students to complete an in-depth research project that builds upon their middle school earth, life, or physical science experience. Students will critically review literature on their chosen research problem, design and conduct a long-term study, and report the results. Students will participate in on-going peer reviews that will help students refine their research protocol, analysis, and conclusions. There will be two culminating evaluative processes. First, students will present their findings at a "board review" at the local school, before teachers, parents, and a panel of "science experts." Second, students will present their research in one of several formats such as the following: at a regional or national meeting; as part of regional or national competition, e.g., Science and Engineering Fair, FIRST Robotics, or selected Science Olympiad events; or state, regional, or national publication.

Major Concepts/ Skills:	**Concepts/Skills to Maintain:**
Establish focused research problem	Characteristics of Science
Scientific literature review	Records investigations clearly and accurately
Systems analysis	Uses scientific tools
Digital data collection & analysis	Interprets graphs, tables, and charts
Institutional Research Board approval	Writes clearly
Peer review	Uses proper units
Scientific publication & presentation	Organizes data into graphs, tables, charts
Scientific documentation	Uses models
	Asks quality questions
	Uses technology
	Uses safety techniques
	Analyzes data via calculations and inference
	Recognizes the importance of explaining data with precision and accuracy

Co-Requisite – Characteristics of Science

Habits of Mind

S8CS1. Students will explore the importance of curiosity, honesty, openness, and skepticism in science and will exhibit these traits in their own efforts to understand how the world works.

a. Understand the importance of—and keep—honest, clear, and accurate records in science.
b. Understand that hypotheses can be valuable even if they turn out not to be completely accurate.

S8CS2. Students will use standard safety practices for all classroom laboratory and field investigations.

a. Follow correct procedures for use of scientific apparatus.
b. Demonstrate appropriate techniques in all laboratory situations.
c. Follow correct protocol for identifying and reporting safety problems and violations.

S8CS3. Students will have the computation and estimation skills necessary for analyzing data and following scientific explanations.

a. Analyze scientific data by using, interpreting, and comparing numbers in several equivalent forms, such as integers, fractions, decimals, and percents.
b. Find the mean, median, and mode and use them to analyze a set of scientific data.
c. Apply the metric system to scientific investigations that include metric to metric conversions (i.e., centimeters to meters).
d. Decide what degree of precision is adequate, and round off appropriately.
e. Address the relationship between accuracy and precision.
f. Use ratios and proportions, including constant rates, in appropriate problems.

S8CS4. Students will use tools and instruments for observing, measuring, and manipulating equipment and materials in scientific activities utilizing safe laboratory procedures.

a. Use appropriate technology to store and retrieve scientific information in topical, alphabetical, numerical, and keyword files, and create simple files.
b. Use appropriate tools and units for measuring objects and/or substances.
c. Learn and use standard safety practices when conducting scientific investigations.

S8CS5. Students will use the ideas of system, model, change, and scale in exploring scientific and technological matters.

a. Observe and explain how parts can be related to other parts in a system such as the role of simple machines in complex machines.
b. Understand that different models (such as physical replicas, pictures, and analogies) can be used to represent the same thing.

S8CS6. Students will communicate scientific ideas and activities clearly.

a. Write clear, step-by-step instructions for conducting scientific investigations, operating a piece of equipment, or following a procedure.
b. Write for scientific purposes incorporating information from a circle, bar, or line graph, data tables, diagrams, and symbols.
c. Organize scientific information in appropriate tables, charts, and graphs, and identify relationships they reveal.

S8CS7. Students will question scientific claims and arguments effectively.

a. Question claims based on vague attributions (such as "Leading doctors say...") or on statements made by people outside the area of their particular expertise.
b. Identify the flaws of reasoning in arguments that are based on poorly designed research (e.g., facts intermingled with opinion, conclusions based on insufficient evidence).
c. Question the value of arguments based on small samples of data, biased samples, or samples for which there was no control.
d. Recognize that there may be more than one way to interpret a given set of findings.

The Nature of Science

S8CS8. Students will be familiar with the characteristics of scientific knowledge and how it is achieved.

Students will apply the following to scientific concepts:

a. When similar investigations give different results, the scientific challenge is to judge whether the differences are trivial or significant, which often requires further study. Even with similar results, scientists may wait until an investigation has been repeated many times before accepting the results as meaningful.
b. When new experimental results are inconsistent with an existing, well-established theory, scientists may pursue further experimentation to determine whether the results are flawed or the theory requires modification.
c. As prevailing theories are challenged by new information, scientific knowledge may change.

S8CS9. Students will understand the features of the process of scientific inquiry.

Students will apply the following to inquiry learning practices:

a. Investigations are conducted for different reasons, which include exploring new phenomena, confirming previous results, testing how well a theory predicts, and comparing different theories. Scientific investigations usually involve collecting evidence, reasoning, devising hypotheses, and formulating explanations to make sense of collected evidence.
b. Scientific investigations usually involve collecting evidence, reasoning, devising hypotheses, and formulating explanations to make sense of collected evidence.
c. Scientific experiments investigate the effect of one variable on another. All other variables are kept constant.
d. Scientists often collaborate to design research. To prevent this bias, scientists conduct independent studies of the same questions.
e. Accurate record keeping, data sharing, and replication of results are essential for maintaining an investigator's credibility with other scientists and society.
f. Scientists use technology and mathematics to enhance the process of scientific inquiry.
g. The ethics of science require that special care must be taken and used for human subjects and animals in scientific research. Scientists must adhere to the appropriate rules and guidelines when conducting research.

Reading Standard Comment
After the elementary years, students are seriously engaged in reading for learning. This process sweeps across all disciplinary domains, extending even to the area of personal learning. Students encounter a variety of informational as well as fictional texts, and they experience text in all genres and modes of discourse. In the study of various disciplines of learning (language arts, mathematics, science, social studies), students must learn through reading the communities of discourse of each of those disciplines. Each subject has its own specific vocabulary, and for students to excel in all subjects, they must learn the specific vocabulary of those subject areas *in context.*

Beginning with the middle grades years, students begin to self-select reading materials based on personal interests established through classroom learning. Students become curious about science, mathematics, history, and literature as they form contexts for those subjects related to their personal and classroom experiences. As students explore academic areas through reading, they develop favorite subjects and become confident in their verbal discourse about those subjects.

Reading across curriculum content develops both academic and personal interests in students. As students read, they develop both content and contextual vocabulary. They also build good habits for reading, researching, and learning. The Reading Across the Curriculum standard focuses on the academic and personal skills students acquire as they read in all areas of learning.

S8CS10. Students will enhance reading in all curriculum areas by:

a. Reading in All Curriculum Areas
- Read a minimum of 25 grade-level appropriate books per year from a variety of subject disciplines and participate in discussions related to curricular learning in all areas.
- Read both informational and fictional texts in a variety of genres and modes of discourse.
- Read technical texts related to various subject areas.

b. Discussing books
- Discuss messages and themes from books in all subject areas.
- Respond to a variety of texts in multiple modes of discourse.
- Relate messages and themes from one subject area to messages and themes in another area.
- Evaluate the merit of texts in every subject discipline.
- Examine author's purpose in writing.
- Recognize the features of disciplinary texts.

c. Building vocabulary knowledge
- Demonstrate an understanding of contextual vocabulary in various subjects.
- Use content vocabulary in writing and speaking.
- Explore understanding of new words found in subject area texts.

d. Establishing context
- Explore life experiences related to subject area content.
- Discuss in both writing and speaking how certain words are subject area related.
- Determine strategies for finding content and contextual meaning for unknown words.

Co-Requisite – Content

S8SR1. Students will synthesize science content through standard science research protocols in earth, life, and physical science.

a. Explore qualitative research methodologies (e.g., descriptive, case or ethnographic) that have defined scientific knowledge.
b. Explore quantitative research methodologies (e.g., experimental, quasi-experimental) that have defined scientific knowledge.
c. Compare and contrast qualitative and quantitative science methodologies.
d. Determine appropriate research approaches to specific research problems in earth, life, and physical science.

S8SR2. Students will investigate an accessible scientific research problem in earth, life, or physical science.

a. Establish a research question from the middle school earth, life, or physical science GPS content.
b. Establish an appropriate research protocol for investigating the question, from within the science content of earth, life, and physical science.
c. Collect and analyze data based upon teacher approved protocol.
d. Report research results in regional, national, or international forum (e.g., competitions such as Siemens-Westinghouse, FIRST Robotics, or International Science and Engineering Fair, or selected Science Olympiad events; peer reviewed publications; or presentation at regional or national science conference).

S8SR3. Students will study the context of the accessible research question through system development and analysis.

a. Delineate the core components of the science content system to be studied (e.g., subsystem in earth, life, or physical science).
b. Analyze the characteristics of the system components.
c. Establish relationships between the components of the system being researched (cause and effect, mathematical, or qualitative relationships within the science content).
d. Analyze specific relations established within the research protocol to develop the foundations for the research conclusions.

S8SR4. Students will appropriately employ instrumentation and apply technological analysis to the accessible research question within earth, life, or physical science content.

a. Understand applicable data collection and analysis techniques for studying aspects of the system in question.

b. Establish systematic and appropriate data collection techniques (encourage using appropriate computer technology and/or remote sensing probeware) appropriate to the science content.
c. Record data using appropriate technology.
d. Analyze data using appropriate technology.

S8SR5. Students will demonstrate understanding and application of scientific communication used within the earth, life, or physical science disciplines.

a. Establish a comprehensive literature study that defines the validity of the research question.
b. Determine legal scientific protocols and obtain appropriate approvals:
   - Complete and obtain institutional research board approval for **any** human or animal subject research, (e.g., see International Science and Engineering Fair protocols and forms);
   - Complete and obtain approvals for toxic substance protocols
   - Maintain Material Safety Data Sheets (MSDS).
c. Prepare data and analyses for external review.
d. Establish reports for external publication/presentation, following multiple, on-going peer reviews (e.g., white papers).