Summit High School
Curriculum
Science Research II and Advanced Science Research
One Semester Science Elective for Grades 9-12

Revised Summer 2020 by Christine Stelmach

Course Description

The Science Research electives are designed for students who are committed to completing a long-term, independent research project. Labs, projects and literature review will be driven by student interest. Thus, each student enrolled in Science Research will have a unique experience. Science Research II is a one semester elective that builds on the skills and knowledge acquired in Science Research I. Advanced Science Research is either a one-semester or a year-long class that can be taken multiple times. Students enrolled in two consecutive semesters of Science Research II and Advanced Science Research are expected to complete an independent research project for entry into a competitive, external science fair.

The scope of Science Research goes significantly beyond what is available through the traditional high school science sequence. The overriding condition for success in this program is the sense of ownership and responsibility that the individual student must develop with his or her research project. Students will identify a research topic of interest and broadly read various levels of pertinent scientific literature. Ultimately, a testable hypothesis will be crafted, experiments designed and performed, data analyzed, results discussed and conclusions formed. Time management skills as well as skills in communicating and interacting with science professionals will be acquired. Throughout the year, students will give presentations summarizing their progress. The classroom teacher will provide guidance and feedback while each student struggles with the real life obstacles of scientific research. The teacher will also assist the student in meeting the requirements for an external science fair and writing a research paper suitable for journal publication.

Next Generation Science Standard
Each student in Science Research II and Advanced Science Research has the opportunity to explore science topics, perform experiments and design projects related directly to his or her own interests and motivations and resource availability. The learning experiences of each student will include one or more of the following NGSS: **Physical Science** **HS-PS1** Matter and its interactions **HS-PS2** Motion and Stability: Forces and Interactions **HS-PS3** Energy **HS-PS4** Waves and Their Applications in Technologies for Information Transfer **Life Science** **HS-LS1** From Molecules to Organisms: Structures and Processes **HS-LS2** Ecosystems: Interactions, Energy, and Dynamics **HS-LS3** Heredity: Inheritance and Variation of Traits **HS-LS4** Biological Evolution: Unity and Diversity **Earth Science** **HS-ESS1** Earth's Place in the Universe **HS-ESS2** Earth's Systems **HS-ESS3** Earth and Human Activity **Engineering Design** HS-ETS1 Engineering Design

Big Ideas

Plan and conduct an investigation individually and collaboratively to produce data to serve as the basis for evidence, and in the design: decide on types, how much, and accuracy of data needed to produce reliable measurements and consider limitations on the precision of the data (e.g., number of trials, cost, risk, time), and refine the design accordingly. (HS-PS1-3)

Apply scientific principles and evidence to provide an explanation of phenomena and solve design problems, taking into account possible unanticipated effects. (HS-PS1-5)

Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. (HS-PS1-2)

Use mathematical representations of phenomena to support claims. (HS-PS1-7)

Communicate scientific and technical information (e.g. about the process of development and the design and performance of a proposed process or system) in multiple formats (including orally, graphically, textually, and mathematically). (HS-PS2-6)

Essential Questions *What provocative questions will foster inquiry, understanding, and transfer of learning?*	**Enduring Understandings** *What will students understand about the big ideas?*
● Considering available resources, safety and time, can a research project that will perform well in an external science fair be defined and executed? ● How can the significant time demands of scientific research be managed in the context of a busy student's day? ● How can long and short term goals be used to plan and monitor project progress and ensure that time is utilized appropriately? ● What are the writing skills specific to scientific communication? ● How can community members be identified and used as resources or mentors?	Specific DCI's will be dependent on the project defined by the students. Experiments, models, simulations, and data analysis for different projects will incorporate DCI's from Physical Science, Life Science, Earth Science and Engineering Design.
Areas of Focus: Proficiencies (Cumulative Progress Indicators)	**Examples, Outcomes, Assessments**
Students will: ● Design investigations, collect evidence, analyze data, and evaluate evidence to determine measures of central tendencies, causal/correlational relationships, and anomalous data. ● Build, refine, and represent evidence-based models using mathematical, physical, and computational tools. ● Revise predictions and explanations using evidence, and connect explanations/arguments to established scientific knowledge, models, and theories.	**Instructional Focus:** Students will be able to: ● Prioritize research articles according to the student's personal interest ● Narrow the search parameters to focus on specific topics based on time constraints, skills required, and personal interest ● Demonstrate that independent research follows a progression from general research articles (review articles) to more specific scientific papers. ● Collect, read, prioritize, and abstract articles. ● Consider the requirements of the different science fairs recognizing that each

● Develop quality controls to examine data sets and to examine evidence as a means of generating and reviewing explanations. ● Reflect on and revise understandings as new evidence emerges. ● Use data representations and new models to revise predictions and explanations ● Consider alternative theories to interpret and evaluate evidence-based arguments. ● Engage in multiple forms of discussion in order to process, make sense of, and learn from others' ideas, observations, and experiences ● Represent ideas using literal representations, such as graphs, tables, journals, concept maps, and diagrams.	competition has different requirements that must be addressed. ● Formulate a project plan for a given competition (individual/team). ● Develop a research plan that assigns resources and time to a specific task thereby successfully managing time. ● Develop a project time "time-line" and modify as appropriate ● Incorporate short-term and long-term goals into an overall research plan ● Use self-assessment, peer review and instructor feedback to monitor completion of goals. ● Substantiated goal completion with credible evidence. ● Know the structure of a scientific paper and that a written paper is the primary method of conveying research results. ● Understand that scientific writing is a learned technical skill that requires practice, reflection and review. ● Identify professionals in the field affiliated with their topic of interest. ● Effectively use current family/professional contacts. ● Search online for local, state and national mentorship programs. ● Determine whom to contact in a multi-person laboratory facility. ● Write an introductory letter to a potential mentor. **Sample Assessments:** ● Annotated Bibliography ● Research Proposal ● Research Plan ● Laboratory Notebook Check ● Science Fair Registration ● Project Updates and Presentations ● Article Abstracts ● Participation in Literature Circles ● Goal sheet **Instructional Strategies:** ● Teacher-Student interaction on improvement strategies ● How to use peer review form activity (how to provide feedback to each other) ● Modeling of peer review by instructors ● Modeling of peer review by older students ● Meeting planning presentation ● Guided practice ● Individual practice

	● Contact/introduction letter activity (process of finding a mentor and introducing yourself). ● Contact vs. mentor activity. ● Modeling by older students. ● Abstract writing activity. ● Review of contest requirements. **Interdisciplinary Connections** ● **ELA/Literacy: RST.11-12.7** Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., qualitative data, video, multimedia) in order to address or solve a problem. ● **ELA/Literacy: RST.11-12.8** Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information. ● **ELA/Literacy: RST.11-12.9** Synthesize information from a range of sources (e.g., texts, experiments, simulations) into a coherent understanding of a process, phenomenon, or concept, resolving conflicting information when possible. ● **ELA/Literacy: RST.11-12.1** Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account. ● **ELA/Literacy: WHST.9-12.2** Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS1- 2),(HS-PS1-5) ● **ELA/Literacy: SL.11-12.5** Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4) ● **Mathematics: MP.2** Reason abstractly and quantitatively. ● **Mathematics: MP.4** Model with mathematics. (HS-PS4-1) ● **Mathematics: HSA-SSE.A.1** Interpret expressions that represent a quantity in terms of its context. (HS-PS4-3) **Technology Integration** ● Use Excel and other software programs to tabulate, graph and manipulate data. ● Use computer based laboratory probes or sensors for data collection.

	● Google Suite ● SHS library databases and Google Scholar ● Public databases ● Use of technology is critical in presenting information and results in meetings with slide presentations and platforms like Google Meet and Zoom ● Navigate online science fair registrations including use of e-documents and electronic signatures. ● Create project videos for online science fairs. ● Explore online project planning platforms. ● Obey email etiquette when communication with teachers, professionals and mentors. **Media Literacy Integration** ● Obtain multiple perspectives by accessing media from both the professional scientific and public sectors. ● Use textbooks, articles and other media to enhance background knowledge, design procedures and solve problems. ● Utilize SI units in lab notebooks and scientific writing. ● Explore articles and excerpts from *Science*, *Science News*, *Physics Today* and other publications. **Global Perspectives** ● Science is an international endeavor. ● Science Fairs may be regional, national or international. ● While student cultures may be diverse, everyone shares a common goal of recognition for excellence and hard work. ● All cultures around the world put emphasis on personal integrity. ● Live discussions with colleagues around the world is now routine. ● The scientific writing style is internationally universal.

	Students will understand that… Logically designed investigations are needed in order to generate the evidence required to build and refine models and explanations. Mathematical tools and technology are used to gather, analyze, and communicate results. Empirical evidence is used to construct and defend arguments. Refinement of understandings, explanations, and models occurs as new evidence is incorporated. Science involves practicing productive social interactions with peers, such as partner talk, whole-group discussions, and small-group work. Science involves using language, both oral and written, as a tool for making thinking public. Scientific reasoning is used to evaluate and interpret data patterns. Students will understand that… Science is a practice in which an established body of knowledge is continually revised, refined, and extended as new evidence emerges. Data and refined models are used to revise predictions and explanations.

Curricular Addendum

Career-Ready Practices **CRP1**: Act as a responsible and contributing citizen and employee. **CRP2**: Apply appropriate academic and technical skills. **CRP3**: Attend to personal health and financial well-being. **CRP4**: Communicate clearly and effectively and with reason. **CRP5**: Consider the environmental, social and economic impacts of decisions. **CRP6**: Demonstrate creativity and innovation. **CRP7**: Employ valid and reliable research strategies.	**Interdisciplinary Connections** ● Close Reading of works of art, music lyrics, videos, and advertisements ● Use Standards for Mathematical Practice and Cross-Cutting Concepts in science to support debate/inquiry across thinking processes **Technology Integration** Ongoing: ● Listen to books on CDs, Playaways, videos, or podcasts if available. ● Use document camera or overhead projector for shared reading of texts.

CRP8: Utilize critical thinking to make sense of problems and persevere in solving them.
CRP9: Model integrity, ethical leadership and effective management.
CRP10: Plan education and career paths aligned to personal goals.
CRP11:. Use technology to enhance productivity.
CRP12: Work productively in teams while using cultural global competence.

Other:

- Use Microsoft Word, Inspiration, or SmartBoard Notebook software to write the words from their word sorts.
- Use available technology to create concept maps of unit learning.

Instructional Strategies:
Supports for English Language Learners:

Sensory Supports	Graphic Supports	Interactive Supports
Real-life objects (realia)	Charts	In pairs or partners
Manipulatives	Graphic organizers	In triads or small groups
Pictures & photographs	Tables	In a whole group
Illustrations, diagrams, & drawings	Graphs	Using cooperative group
Magazines & newspapers	Timelines	structures
Physical activities	Number lines	With the Internet (websites) or software programs
Videos & films		In the home language
Broadcasts		With mentors
Models & figures		

from https://wida.wisc.edu

Media Literacy Integration

- Use multiple forms of print media (including books, illustrations/photographs/artwork, video clips, commercials, podcasts, audiobooks, Playaways, newspapers, magazines) to practice reading and comprehension skills.

Global Perspectives

- The Global Learning Resource Library

Differentiation Strategies:

Accommodations	Interventions	Modifications
Allow for verbal responses	Multi-sensory techniques	Modified tasks/ expectations
Repeat/confirm directions	Increase task structure (e.g., directions, checks for understanding, feedback)	Differentiated materials
Permit response provided via computer or electronic device	Increase opportunities to engage in active academic responding (e.g., writing, reading aloud, answering questions in class)	Individualized assessment tools based on student need
Audio Books	Utilize prereading strategies and activities: previews, anticipatory guides, and semantic mapping	Modified assessment grading