Advanced STEM Research Laboratory

Curriculum, WA State Learning Standards, Next Generation Science Standards

Students engaging in Advanced STEM Research will: 1) make observations on the real world, 2) create questions regarding their observations utilizing background research, 3) formulate a hypothesis or engineering goal centered on those questions/observations, 4) develop a method of quantitative experimentation, 5) analyze the data set using appropriate statistical analysis, 6) and discuss/conclude the details of the results in a concise, scientific manner. During the entire process, a scientific journal will chronologically keep any and all research questions, ideas, data, and analysis. Each student will be required to use technological means for creating, experimenting, or statistically analyzing the data sets. Once the journal article has been completed, reviewed, and approved, each student will create a presentation both physically (poster board) as well as digitally (PowerPoint), and present the scientific research to the scientific community.

Week	Goals - Instruction Recourses	Student Work	Assessment	Learning Standards	Next Gen Science Standards
1	**Discipline of STEM.** **Scientific research is explained and reviewed. Current and classic examples shown. A sample journal article and student work given to students.** **Syllabus and timeline for class reviewed.** **Students will be asked to decided a field of study interest.** **Some examples include: Animal STEM, Behavioral/Social STEM, Biochemistry, Cellular/Molecular Biology, Chemistry, Computer STEM, Earth STEM, Engineering (materials, bioengineering, electrical, mechanical), Energy / Transportation STEM, Environmental Analysis, Environmental Management, Mathematical STEM, Medicine / Health STEM, Microbiology, Physics/Astronomy, or Plant STEM.** **Acceptable and not acceptable examples given.**	Students brainstorm ideas for their research project. Research previous experiments to assist in the decision process. All information will be kept in science journal	Students are given a research journal to keep all data and references in. Students are told how to keep the journal chronological and organized for use, grading and final presentation at events. Students are informed that weekly journal checks as well as milestones in research process will be basis for grade. A minimum of 2 ideas for research project are due by the end of the week ; written in journal.		HS-PS1-3. Chemistry HS-PS1-4. Chemistry HS-PS1-6. Chemistry HS-PS1-8. Chemistry HS-PS2-5. Physics HS-PS3-1 - 5 Physics HS-LS1-3. Biology HS-LS2-5. Biology HS-LS4-6. Biology HS-ESS1-1. Earth HS-ESS1-2. Earth HS-ESS2-1. Earth HS-ESS2-3. Earth

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2 and 3	**Draft and Finalize Letter to Email.** Using the Internet, locate and begin a correspondence with professionals within the discipline chosen during universities, colleges, vocational institutes, scientific businesses. Develop cutting edge ideas and questions regarding a specific scientific interest. Acceptable and not acceptable examples given.	With research ideas in mind students are to draft letters to scientists and other professionals currently in the field related to the research topics they have chosen. These letters are inquiry based; looking for information, answers to specific questions and possible continuing personal support. All correspondence is saved and logged in journal.	Journal will be checked weekly for correspondence with scientists. A minimum of 2 letters of correspondence is required. This is for each research idea. If a final idea has been decided; 4 different passes of correspondence is required. Full list of all contact information of mentors and contacts clearly listed in journal. E-journal in the form of an email file created. All correspondence will be cc'd to the instructor.	EALR 2: INQ G	

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4 and 5	**Background Research**. Using the Internet, locate journal articles, scientific publications, scientific news articles, or even phone conversations regarding the ideas and questions created during Weeks 2 and 3. Have a solid understanding of the processes, terminology, people and places in the particular field and methods behind specific scientific ideas and questions. Acceptable and not acceptable examples given.	At this point the student has decided the research they will conduct. They are to research: -supplies needed -previous experimentation -the scientific processes they will be working with -time lines and possible issues they may face Student will need to provide evidence in the form of journal articles, emails, internet articles, etc.	Journal will be checked on a weekly basis. Required: -list of minimum 8 journal articles of past experimentation. - Beneficial communication with current scientist. -list of supplies needed -draft of timeline -draft of method	EALR 2: INQ H EALR 3: APP A EALR 4: PS1 A-H EALR 4: PS2 A-K EALR 4: PS3 A-E EALR 4: ES1 A&B EALR 4: ES2 A-D EALR 4: ES3 A-D EALR 4: LS1 A-H EALR 4: LS2 A-F EALR 4: LS3 A-E	HS-PS1-1. Chemistry HS-LS2-6. Biology HS-ESS2-2. Earth HS-ESS3-2. Earth HS-ESS3-4. Earth HS-ESS3-5. Earth HS-ETS1-1. Engineering

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Week	Goals - Instruction Recourses	Student Work	Assessment	Learning Standards	Next Gen Science Standards
6	**Hypothesis**. The hypothesis needs to be both quantifiable as well as testable. What equipment will be needed to gather data? Begin a rough sketch of the Materials and Methods needed to test and execute the research while creating a solid hypothesis. Email the hypothesis to any or all contacts made during Weeks 2-5 for advice or critiquing. Acceptable and not acceptable examples given.	Student will write a workable hypothesis for their research. Make a list of all supplied needed to complete the work. Make a draft of the procedure, steps, and time line needed. Email the hypothesis to mentors for critique.	Journal checked for notes and communication with mentors. Journals will be checked for all the work listed in the student work to the left.	EALR 2: INQ A EALR 3: APP B	HS-LS2-7. Biology HS-LS3-1. Biology

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6	**Introduction and Hypothesis**. Set the stage for the main scientific argument. This section of the paper should interest or "hook" the reader, creating an awareness of the potential significance of the research. This piece describes the particular issue or issues that the paper will address, why these issues are important, and provides the reader with a brief introductory knowledge regarding terminology or processes unique to your research. Make sure the reader understands why such observations are needed by citing similar studies done by others. As the literature is being cited, begin creating a rough Literature Cited and References draft in APA Journal Style Format. The last paragraph of the Introduction should explain and describe the hypothesis. Acceptable and not acceptable examples given.	Student will write a draft of the introduction. This draft will be reviewed by instructor and revised a minimum of 3 times by the end of the week.	Journal checked for notes and communication with mentors. Three drafts of the introduction reviewed.	EALR 3: APP C EALR 4: PS1 A-H EALR 4: PS2 A-K EALR 4: PS3 A-E EALR 4: ES1 A&B EALR 4: ES2 A-D EALR 4: ES3 A-D	HS-PS1-2. Chemistry HS-ESS2-4. Earth HS-ESS3-1. Earth

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Week	Goals - Instruction Recourses	Student Work	Assessment	Learning Standards	Next Gen Science Standards
7	**Valid Materials and Method.** This section explains to the reader how the research was conducted to get the new data presented. Mold the methodology that provides the context for evaluating the data. Plates (pictures), drawings, and figures are almost a must for this section. Possible explanations as to why the procedure was conducted in the manner chosen. This section should be so complete that a person with little scientific knowledge could completely reproduce the procedure created. Acceptable and not acceptable examples given.	Students are to write a draft of the methods and materials for the research. This will be reviewed and revised. Minimum of three revisions by the end of the week.	Journal checked for notes and communication with mentors. Drafts of methods and materials reviewed and graded. Minimum of three revisions for full credit.	EALR 1: SYS B EALR 2: INQ B EALR 2: INQ D	HS-PS1-3. Chemistry HS-PS1-4. Chemistry HS-PS1-6. Chemistry HS-PS2-3. Physics HS-ESS2-6. Earth HS-ESS3-3. Earth HS-ETS1-2. Engineering

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Week	Goals - Instruction resources	Student Work	Assessment	Learning Standards	Next Gen Science Standards
8 and 9	**Submission and Approva**l from Scientific Review Committee and/or the Institutional Review Board. A Scientific Review Committee (SRC) is a group of adults knowledgeable about regulations concerning experimentation especially with vertebrate animals and potentially hazardous biological agents. The SRC must review and approve all projects in these areas before experimentation may begin. Shortly before competition, the Fair SRC will also review the documentation for ALL projects to ensure that students have followed all applicable rules and that the project is eligible to compete. The Institutional Review Board (IRB) is constructed to evaluate the potential physical or psychological risk of research conducted by high school students. Members of the SRC and/or the IRB read each research proposal and assess if each individual project warrants more information before data collection begins. Acceptable and not acceptable examples given.	Student will review their research project in relation to the SRC regulations. Then collect the appropriate paperwork for the approval of their work. Then fill out all paperwork and have it reviewed by the instructor. Finally submit all paperwork. Student will do ample work as follow up to each submission making sure it is complete and timely.	Journal will be checked for a list of: -SRC regulations that relate to students study. -List of paperwork needed, locations of paper work, and due dates. -Notes on dates and times paper work was submitted and confirmation it was completed on time. Instructor will check off all paperwork and assist with any signatures needed.	EALR 2: INQ D	

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Week	Goals - Instruction resources	Student Work	Assessment	Learning Standards	Next Gen Science Standards
10 Thru 12	**Experimentation.** Data collection using the created and SRC/IRB approved Materials and Method. One on one help throughout the process will be needed. Each student will need specific help related to the field of study. Keeping student on task and positive about study is important. Issues will come up and they need the instructor to keep the momentum moving. Acceptable and not acceptable examples given.	Students are expected to follow the method steps they have created. They are to keep on task and follow a schedule in order to get the experiment complete on time. All changes or items to note will be logged in journal. Photographs and or video will be taken at all stages of the experiment.	Journal will be checked as often as possible. Notes should be taken in journal on a daily basis. Any changes or surprises will be logged. Evidence of photographs will be checked as well. Communication with mentors at minimum of weekly.	EALR 2: INQ B EALR 4: PS1 A-H EALR 4: PS2 A-K EALR 4: PS3 A-E EALR 4: ES2 A-D EALR 4: ES3 A-D EALR 4: LS1 A-H EALR 4: LS2 A-F EALR 4: LS3 A-E	HS-PS1-3. Chemistry HS-PS1-5. Chemistry HS-LS1-4. Biology HS-LS1-5. Biology HS-LS1-7. Biology HS-LS2-3. Biology HS-ESS2-5. Earth

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Week	Goals - Instruction resources	Student Work	Assessment	Learning Standards	Next Gen Science Standards
13	**Statistical Analysis of Data.** Analyzing and comparing the experimental data with the control data. Choosing the correct statistical tool: Chi Square, t-test, z-test, ANOVA, or many others. Each type of statistical formula reviewed by instructor. Acceptable and not acceptable examples given.	Students will take all data from work and use appropriated statistical analysis to test data for significance. A true understanding of these formulas will be needed not only to conduct the tests, but also to be able to speak about these formulas at the scientific events.	Journal will be check for notes on statistical formulas to be used in project. Mentor communication relating to formulas used in journal is required. All data taken during experiment should be in journal. This data needs to be organized and easy to read. Test results listed clearly.	EALR 1: SYS C EALR 1: SYS D EALR 2: INQB EALR 2: INQ C EALR 2: INQ D EALR 2: INQ F	HS-PS1-7. Chemistry HS-PS2-1. Physics HS-PS2-2. Physics HS-PS2-4. Physics HS-PS4-1 - 5. Physics HS-LS2-1. Biology HS-LS2-2. Biology HS-LS2-4. Biology HS-LS4-3. Biology HS-ESS1-3. Earth HS-ESS1-4. Earth HS-ESS3-6. Earth

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Week	Goals - Instruction resources	Student Work	Assessment	Learning Standards	Next Gen Science Standards
14	**Interpretation of Data.** Making sense of the data and recognizing important trends and patterns. Creating the correct graphs: scatterplot, bar / column, pie, or many others. Acceptable and not acceptable examples given.	Student will take all data and stat test results then create: -a table of data -a graph representing the results of the data -additional graphs or visual representations of data and the results of the stat tests. Draft paragraphs describing the results and meaning in relation to the hypothesis.	Journal will be checked for all requirements listed to the left. Correspondence with mentors about data, stat test, and stat test results will be required.	EALR 2: INQ C EALR 2: INQ D EALR 2: INQ F EALR 3: APP D	HS-PS1-7. Chemistry HS-PS1-8. Chemistry HS-LS2-4. Biology HS-LS3-2. Biology HS-LS3-3. Biology HS-LS4-1. Biology HS-LS4-2. Biology HS-LS4-4. Biology HS-LS4-5. Biology HS-ESS1-5. Earth HS-ETS1-4. Engineering

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Week	Goals - Instruction resources	Student Work	Assessment	Learning Standards	Next Gen Science Standards
15	**Results.** Summarize and illustrate the findings. Create tables showing the mean, standard deviation, variance, and population of each trial; minimum and maximum values from your data set are not uncommon. Since the experiment is trying to show the relationship of the experimental data compared with the control data, then the results should include sentences that relate to this topic. Any data supported by graphs or tables in the report should reveal a "trend" for that data. Input these trends in the results, specifically if the trend is positive (slope rises) or inverse/negative (slope falls), including standard deviation. Acceptable and not acceptable examples given.	Students will create a draft of the results portion of the paper. This will include all items listed to the left. Minimum of 3 full drafts created with reviews of the instructor.	Journal checked for notes and communication with mentors. Each portion of the results checked and reviewed. Three or more drafts reviewed.	EALR 1: SYS A EALR 2: INQ C EALR 2: INQ D EALR 2: INQ F EALR 3: APP E EALR 4: PS1 A-H EALR 4: PS2 A-K EALR 4: PS3 A-E EALR 4: ES1 A&B EALR 4: ES2 A-D EALR 4: ES3 A-D EALR 4: LS1 A-H EALR 4: LS2 A-F EALR 4: LS3 A-E	HS-PS2-6. Physics HS-LS2-4. Biology

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16	**Discussion and Conclusion** Explain to the reader what the newfound data means and tie in any findings by other researchers. Describe how the interpreted data fits any direct observations or any derived quantities presented in the previous sections. This interpretation should lead the reader to some new insight to the particular research area: perhaps a re-determination of some critical idea used by other researchers, a new refinement to a theory, or evidence that some previously-held understanding is incomplete or incorrect in some fundamental way. Often in the past, this portion is the most neglected because it is left until the end to complete; however, this segment of the research paper is perhaps the most important! It should also include the "real world" relevance of why the topic that was chosen may or may not impact the scientific world.	Students will create a draft of the discussion portion of the paper. This will include all items listed to the left. Minimum of 3 full drafts created with reviews of the instructor.	Journal checked for notes and communication with mentors. Each portion of the discussion checked and reviewed. Three or more drafts reviewed.	EALR 2: INQ C EALR 2: INQ D EALR 2: INQ F EALR 3: APP E EALR 3: APP F EALR 4: ES1 A&B EALR 4: ES2 A-D	HS-PS1-5. Chemistry HS-LS2-8. Biology HS-ESS1-6. Earth HS-ESS2-7. Earth HS-ETS1-3. Earth

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16	**Appendix or Appendices.** Often in research, a particular bit of information needed to help explain methodology, mathematical computation, or literature needed to support experimentation (such as questionnaires for human studies) is too large for the main body of the research paper. In this case, it is common to refer to the larger portion as, say, Appendix A, linking it from a descriptive sentence in the main portion of the paper. Create your Appendix during this timeframe if needed. Acceptable and not acceptable examples given.	Students will create a draft of the appendix portion of the paper. This will include all items listed to the left. Minimum of 3 full drafts created with reviews of the instructor.	Journal checked for notes and communication with mentors. Each portion of the appendix checked and reviewed. Three or more drafts reviewed.		

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17 and 18	**References and Literature Cited.** Cite journal articles / sources used throughout the research paper. Do not cite dictionaries, encyclopedias, websites, or other reference materials unless the material is very specific. In this portion, the research should be supported by journal articles paralleling your research. Acceptable and not acceptable examples given.	Students will create a draft of the references portion of the paper. This will include all items listed to the left. Minimum of 3 full drafts created with reviews of the instructor.	Journal checked for notes and communication with mentors. Each portion of the reference checked and reviewed. Three or more drafts reviewed.	EALR 2: INQ D EALR 2: INQ F EALR 2: INQ H EALR 4: ES1 A&B	

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17 and 18	**Abstract.** In usually 200-250 words or less, write a paragraph summarizing your entire research. Although the abstract needs to introduce your research, as well as explain the high-lites of the methodology, the focus should be on your findings and the implications of your findings. Acceptable and not acceptable examples given.	Students will create a draft of the abstract portion of the paper. This will include all items listed to the left. Minimum of 3 full drafts created with reviews of the instructor.	Journal checked for notes and communication with mentors. Each portion of the abstract checked and reviewed. Three or more drafts reviewed.	EALR 2: INQ G	

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17 and 18	**PowerPoint and Poster Display.** Using the final draft of the journal paper, create a PowerPoint presentation for digital sharing as well as a poster display for close contact sharing. Certain symposia require PowerPoint while others use a traditional poster board display. Acceptable and not acceptable examples given.	Student will create: -final draft of the research paper. -a PowerPoint presentation. -a poster board display: physical poster in pieced together paper form or printed poster form; and a digital format.	Final paper reviewed and approved. PowerPoint reviewed and approved. Poster board (physical and digital) reviewed and approved. Communication with mentor checked.	EALR 2: INQ G	

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Week	Goals - Instruction resources	Student Work	Assessment	Learning Standards	Next Gen Science Standards
19 Thru 34	**Presentation to Scientific Community.** Share your scientific findings with the local community, businesses of interest, government agencies, other interested research facilities or universities, and various science symposia, fairs, and events. Acceptable and not acceptable examples given.	Student will be ready to present all work to the community. Student will sign up for local and regional presentations from science fairs to symposiums. Presentations to class and school will be done as trial practices.	Presentation from paper, physical board, to student verbal speech on work will be reviewed, critiqued and approved. Student will be graded on readiness for presentations as well as if they are properly signed up for all events.	EALR 2: INQ G	HS-PS2-6. Chemistry

Advanced STEM Research Laboratory

Curriculum, WA State Learning Standards, Next Generation Science Standards

Students engaging in Advanced STEM Research will: 1) make observations on the real world, 2) create questions regarding their observations utilizing background research, 3) formulate a hypothesis or engineering goal centered on those questions/observations, 4) develop a method of quantitative experimentation, 5) analyze the data set using appropriate statistical analysis, 6) and discuss/conclude the details of the results in a concise, scientific manner. During the entire process, a scientific journal will chronologically keep any and all research questions, ideas, data, and analysis. Each student will be required to use technological means for creating, experimenting, or statistically analyzing the data sets. Once the journal article has been completed, reviewed, and approved, each student will create a presentation both physically (poster board) as well as digitally (PowerPoint), and present the scientific research to the scientific community.

Week	Goals - Instruction resources	Student Work	Assessment	Learning Standards	Next Gen Science Standards
19 Thru 34	**Fine-Tune Your Research and Update.** Many of the events where you will present do not demand that your research stop by any means. Therefore, you should continue further research that will stem from your current research: run more trials to solidify your results, reflect on your limitations and see if it is possible to overcome the limitations in your time left, or make connections with new contacts along the way. Any changes to your data require going back and reworking your Materials and Methods, your Results, your Discussion and Conclusion, and possible other areas of your paper. Acceptable and not acceptable examples given.	Student will review self work for any questions that a scientist or viewer of the work might ask. Student will prepare for these questions by: -researching all aspects of issues related to results and being fully prepared to speaker to this. -have all data related to new information found. -have a list of possible 'next' steps for the research to go to.	Journal will be checked for notes and all mentor communication. A list of all issues or ideas that have come up since finalizing research. All new findings with list of references. Possible ideas for next steps from realistic to fantasy ideas. Student able to speak about all avenues well.	EALR 2: INQ G	

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35 and 36	**Clean Up and Thank You.** Clean up all lab ware and supplies, check materials borrowed back in to surplus room, and write, acknowledge, and thank the people and places that contributed toward the research project this year. Acceptable and not acceptable examples given.	Student will clean up all lab work related to their research. Student will send out thank you to all individuals involved in process. Students will send updates and invites to events to all individuals involved.	Instructor will check that all supplied are cleaned up and or returned if borrowed. Thank you, updates and invites will be checked for appropriateness and timeliness.		