Supplemental Material

CBE—Life Sciences Education
Eeds *et al.*

The School for Science and Math at Vanderbilt

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Summary of Supplemental Materials

SSMV Curriculum Overview

Example Days for Each SSMV Grade: A Day in the Life…

SSMV Course Grading

SSMV Critical Thinking Criteria Progression

SSMV Curriculum Overview

The curricular focus, components, and projects for each course by class are outlined in the table. IS=interdisciplinary science; R=research; AR=advanced research; AY=academic year; S=summer.

Grade	Courses	Curriculum Focus	Curricular Components	Projects
9	ISI (AY) RI (S)	• Learning how to ask a good question	• Class-wide learning through guest lessons and hands-on laboratories with daily themes centered around a question • Class-wide project with small groups focusing on the same research question	• Accessing and utilizing scientific literature • Investigation of a class-wide research project
10	ISII (AY) RII (S)	• Learning how to design and answer a research question	• Small group, research-based learning, led by an SSMV instructor	• Small group investigation of a class-wide project, each group investigating a different aspect of the project • Small group projects focused on student-designed research questions
11	ISIII (AY) RIII (S)	• Investigating potential outcomes of scientific ideas and their impact on society • Improving scientific reading, analysis, and critical thinking skills through completion of research projects	• Peer learning through small group discussions, book critiques, and journal club presentations • Development and implementation of an independent research project	• Participation in research internships in Vanderbilt laboratories
12	Advanced Research (AY)	• Learning to communicate scientific results to the science community • Learning to communicate scientific results to the public	• Practice of written and oral communication skills through professional and peer review • Culmination of class-wide and small group learning through collaboration with a community partner mentor	• Writing and submission of independent research projects to national science competitions • Design and implementation of community-engaged research projects

Example Days for Each SSMV Grade: A Day in the Life…

Grade	Example Day
9th	*Your body is a universe: How many species do you support?* Students examine the diverse nature of the interactions of living organisms. The day starts with clicker quiz to identify microorganisms that live as parasites or symbiotes on humans. Following is a presentation by a Vanderbilt researcher about mosquitoes and the spread of malaria. Students then discuss their observations of biodiversity in their own environments and participate in a forum on how to cure or prevent several infectious diseases that threaten global human health by deciding which of three grant proposals should be funded. Students are finally guided through the design of their own experiments to investigate the presence and abundance of microorganisms on the food that we consume. Students complete an out of class challenge that asks them to complete an essay on whether the controversial results of recent H5N1 studies should be published.
10th	*The RNA World Hypothesis* Students spend the majority of the day working in their small groups to complete a portion of the semester-long plant DNA sequencing project. The morning begins with a lesson on a popular molecular biology technique, the Polymerase Chain Reaction (PCR). Then, students perform this protocol on their plant DNA samples to amplify the GAPDH gene from DNA isolated in a previous week. To complement knowledge of DNA, students also engage in a lesson on RNA from a chemistry perspective and then learn about the hypothesis that this nucleic acid arose in primitive earth. They debate this evidence and also split into small groups led by instructors for discussions on the semester reading, *The Double Helix* by James Watson.
11th	Students begin the day in their Journal Club groups, each mentored by one of the four instructors. Each week there is a student presenter who leads the rest of the group through a scientific publication of their choosing. Students discuss the data, analyze the figures, and discuss the merits of this research to the larger field. Following Journal Club, students engage in one of three Perspectives Forums which are small group discussion-based settings where students either cover such topics as Famous Scientists, Ethics, or Technology. In the afternoon, students work in the laboratories they have been matched with, using the academic year time to prepare for the upcoming fulltime, six-week summer research internship.
12th	Each class day, students work towards generating and implementing a community-oriented research project in partnership with a leader in the local community. Students choose their project and work in a team of 2-4 students to engage the community in scientific research. Some projects require that the students spend a portion of class time teaching younger students, while other projects involve students collecting data in local neighborhoods, green spaces, and waterways. The class comes together for an afternoon meeting to report progress, work on their research outputs, and provide feedback to their peers.

SSMV Course Grading

Grading for the SSMV courses includes a variety of assignments and projects, with emphasis changing during the curriculum progression. For example, weekly challenges and class participation is weighted heavily in the first two years, with lab notebooks and laboratory work important in later years. Weekly challenges include out-of-class assignments; participation includes in-class and online participation; in-class assignments include quizzes and notes from in-class presentations; laboratory notebooks and binders include all notes and write-ups of lab projects and field trips; extended challenges include semester-long project reports and papers. IS=interdisciplinary science; R=research.

Course	Assignment	% of Semester Grade
IS-I	Weekly challenges	45
	Participation	30
	In-class assignments	10
	Research binder	15
R-I	Participation	50
	Lab notebook and experimentation	30
	Project and presentation	20
IS-II	Weekly and extended challenges	35
	Participation	50
	In-class assignments	5
	Lab notebook	10
R-II	Participation	55
	Lab and field notebook	30
	Presentation	15
IS-III	I2P module assignments	20
	Written assignments (lab application; TJAS submission)	30
	Science and Society module assignments	15
	Participation	35
R-III	Lab participation and performance	55
	Research symposium	25
	Breakout session participation	20
Advanced Res	Competition submissions	40
	Lab journal	40
	Mentor assessments	10
	Research presentation	5
	In-class assignments	5

Category	Freshmen	Sophomores	Juniors	Seniors
Scientific Thinking	Thinking beyond the scientific facts and asking questions	Thinking beyond the scientific facts by recognizing issues that form the basis of new questions	Using scientific facts to predict how modifying the design or methods of an experiment will effect results	Choosing an interdisciplinary approach to formulate the next research question
Problem Solving	Exploring alternative explanations or methods for solving problems	Identifying an alternative method for testing a hypothesis	Solving multi-step problems that involve integrating concepts, planning, visualization, and/or making connections among multiple disciplines	Conducting community engaged research to identify a local health or wellness problem
Communication (scientific)	Communicating with School for Science and Math scientists and staff	Communicating with scientists using scientific vocabulary	Communicating a critical thesis that clearly establishes the focus of my position on an issue	Communicating research findings to a scientific audience that meet professional standards for written or oral communication
Communication (public)	Communicating science to the public	Communicating science to the public by identifying scientific ideas that are important to the community	Orally communicating the results of research projects to the public	Communicating research findings to engage the public in making measurable improvements in their communities
Science Content	Understanding advances in scientific research	Understanding technical descriptions of advances in scientific research	Making use of primary research literature to understand current advances in a scientific field	Contributing to primary research in my field of study
Research Strategies	Using data in manageable and meaningful ways in research investigation	Using new information to make a prediction based on a model	Identifying an additional trial or experiment that could be performed to enhance or evaluate experimental results.	Formulating an original hypothesis based on a synthesis of my own research and a review of the scientific literature
Analysis of Data	Understanding the theoretical concepts, ideas, technology and methodology in data analysis	Identifying and/or using a complex mathematical relationship between data	Determining whether given information supports or contradicts a complex hypothesis or conclusion and why	Critically analyzing the quality of data generated in my own research
Support and Feedback	Taking advantage of support from a variety of sources	Contributing to other students' learning	Supporting other students at SSMV, my zoned school, and in the community to excel in science and mathematics	Developing relationships with scientists and fellow SSMV students that will continue beyond high school
Scientific Careers	Understanding how to pursue careers in science	Developing specific plans to pursue careers in science, mathematics or related fields	Identifying scientists, mathematicians or others in the research community as possible career mentors	Choosing a career path that makes the best use of my particular interests and talents that I have discovered through my SSMV experience
Use of Technology	Utilizing technology	Gathering and	Using software to create	Choosing the most

	such as data analysis software and internet resources	organizing data through the use of scientific tools and technology	scientific models to make predictions	appropriate technology to conduct my research and analyze my results

SSMV Critical Thinking Criteria Progression

Using ten categories related to skills important for STEM learning, characteristics defining the progression within these categories from freshman to senior year were developed. These characteristics were used to develop the 10-item survey administered to students to measure self-reported gains.