RESET | Simulating the Department of Defense - Program Objective Memorandum (POM)

AN AEOP EFFORT aeop

Engage | Explore | Explain | Elaborate | Evaluate | Appendix

TEACHER

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SUBJECT/GRADE LEVEL

Subject

Grades 8-12

Materials

- Live Classroom Instruction
  - Projector
  - Copies of lesson resources for distribution to students (See Lesson Plan or Appendix)
  - Chromebooks or laptops for teacher and student research us
  - Physical materials for Engineering Challenges (See Elaboration segment)
- Virtual Classroom
  - Chromebooks or laptops for teacher and students
  - Links to lesson resources for distribution to students (See Lesson Plan or Appendix)
  - Physical materials for Engineering Challenges (See Elaboration segment)
  - Instruction videos for asynchronous virtual classrooms (suggestion)

STANDARDS

Next Generation Science Standards

- MS-ETS1-1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- MS-ETS1-2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
- MS-ETS1-3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
- MS-ETS1-4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

- HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.
- HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.
- HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.
- HS-ETS1-4. Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Mathematics Standards | Common Core State Standards

- Modeling with Geometry
  Apply geometric concepts in modeling situations. G.MG.1, 2, 3
- Interpreting Categorical and Quantitative Data
  Summarize, represent, and interpret data on a single count or measurement variable. S.ID.1, 2, 3
- Making Inferences and Justifying Conclusions
  Understand and evaluate random processes underlying statistical experiments. S.IC.1, 2 • Make inferences and justify conclusions from sample surveys, experiments and observational studies. S.IC.3, 4, 5, 6.

English Language Arts Standards | Common Core State

- CCSS.ELA-LITERACY.SL.11-12.1.A: Come to discussions prepared, having read and researched material under study; explicitly draw on that preparation by referring to evidence from texts and other research on the topic or issue to stimulate a thoughtful, well-reasoned exchange of ideas.

LESSON OBJECTIVE(S)

Students will design and systematically evaluate a solution under specific constraints for a societal need and model the impact of their proposed device on the impact of society.

DRIVING QUESTION(S)

Why would investing in this technology help America in our fight against terrorism?

Scientific research is grounded on the need to understand our universe. However, for our US military force, science research is grounded on the development of technologies that provide our warfighters with an advantage over our adversaries. To fund these long-term research projects, Army Researchers must persuade the Department of Defense and eventually Congress to fund their projects. To communicate the need for their research, they produce a Program Objective Memorandum (POM). That process of developing a research idea, backing the idea with research, testing, and peer review, and then publishing a polished research proposal is what this project-based lesson plan simulates in a middle and high school classroom.

CAREER CONNECTION(S)

Mentor Background: Dr. Troy Alexander: I am the Chief of the CCDC ARL Technology Forecasting Office. As office chief, I am responsible for oversight and leadership of the organizational element dedicated to projecting future developments/advances of critical Army technologies. This information is leveraged to inform Army senior leaders about the relevant investments that are required to maintain/enhance the U. S. Army's competitive advantage with respect to technology superiority and operational capabilities. The office considers a broad array of technologies; ranging from Synthetic Biology to Artificial Intelligence to Autonomy, and beyond.

STEM Careers:

ENGAGEMENT Military Gallery

Classroom	Virtual
Teacher Actions: ● The purpose is to access students' prior knowledge and to assess their skills of observations and developing questions; in addition, to assess student content knowledge of existing technological innovations in the military and society. ● Introduction: Elicits student attention by addressing them in the role of a "cadet" with the goal of reflecting on the historical impact of military technologies to determine their prior knowledge. (1 minute) ● Military Gallery: Instruct expectations for observations, inferences, and questions; passes out images to pairs of students; and, progress monitors and promotes student discourse and inquiry. (10 minutes) ● Use slides to have students share their observations, inferences, and questions with the whole class and receive teacher input. (5 minutes) **Student Actions:** ● Military Gallery: Students are partnered and making observations from viewing an image and/or video of a historical event relevant to military technology. They will differentiate between observations and inferences. Form questions about the image(s) and/or video(s) for clarification and to model how students will obtain information for research purposes.	**Teacher Actions:** ● Asynchronous: Record himself/herself instructing the synchronous lesson (below). ● Synchronous ○ Introduce the objective and learning target for the unit. Then narrow the focus of the engagement to placing the students in the role of a "cadet" with the goal of reflecting on the historical impact of military technologies to determine their prior knowledge. (1 minute) ○ Military Gallery Padlet: Instruct students to access the Padlet link and review expectations for completing their observations, inferences, and questions. Encourage student discourse by having students comment on three classmate responses. (15 minutes) (PPT if padlet link no longer works) **Student Actions:** ● Asynchronous: Student views teacher recorded video and completes engagement segment as follows in the synchronous lesson. ● Synchronous: Access online materials following teacher instructions and notes unit and learning objectives. ○ Military Gallery Padlet (PPT): Analyzes images and video. Develops observations, inferences, and questions while responding to peer responses.

EXPLORATION Station Activities

Classroom	Virtual

Activity 1: Station Rotation Exploration
 	
Teacher Actions:
• Teacher will set up various physical stations around the classroom with videos to watch, articles to read and various activities to students to build their knowledge of engineering design.
• Exploration protocol for each station should be set for 15-minutes plus 1 minute of transition time. Protocol will delineate roles of each participant (time keeper, scribe, Leader, etc…)
  ○ Station 1: Video Interview of Dr. Troy Alexander with a worksheet.
  ○ Station 2: Card sort - Engineering Problems and Solutions matching
  ○ Station 3: Websearch - Warfighter Technologies developed by the different military branches challenge: "Who has the best technologies?"
  ○ Station 4: Engineering design Guide with Worksheet.
 	
Student Actions:
Students will be given 15 minutes at each station (exploration protocol for each station should be set for 15 minutes) with 1 minute of transition time.
	Activity1: Station Rotation Exploration
	
	Teacher Actions:
	• Option 1 - Students work asynchronously using the activity hyperdoc and do the Station Rotation on their own or in their working groups unsupervised.
	• Option 2 - Students work synchronously using zoom breakout rooms using the hyperdoc and a clear 15-minute exploration protocol plus 1 minute of transition time. Protocol will delineate roles of each participant (time keeper, scribe, Leader, etc…)
	  ○ Station 1: Video Interview of Dr. Troy Alexander with a worksheet.
	  ○ Station 2: Card sort - Engineering Problems and Solutions matching
	  ○ Station 3: Websearch - Warfighter Technologies developed by the different military branches challenge: "Who has the best technologies?"
	  ○ Station 4: Engineering design Guide with Worksheet.
	
	Student Actions:
	Students will be given 15 minutes at each station (exploration protocol for each station should be set for 15 minutes) with 1 minute of transition time.

EXPLANATION Subject Matter Expert and EDP Design Build Challenge!

Classroom	Virtual
Day 1 - Activity 1 - Introduction to EDP - Subject Matter Expert Teacher Materials: Introduction to EDP - Subject Matter Expert Student Materials: Protocol: What So What Now What (WSWNW) **Teacher Actions:** • Divide the class into working groups of 2-3 persons. • Assign each team 1 of the EDP stages • Allow the teams to learn the assigned EDP stage as a group and guide them through the What, So What, Now What protocol: **Student Actions:** • Individually - Determine what your EDP stage means and be ready to answer the "What and So What?" Questions of your assigned EDP Stage. • Begin the WSWNW Discussion Protocol **Day 1 - Activity 2 - Discussion Groups - So What is the EDP?** **Teacher Actions:** • Divide the class again, this time into 2-3 discussion groups of 7 persons. • Ensure that there is 1 SME representative for each stage of the EDP (based on previous group discussion activity) • Assign each team 1 of the 7 steps of the EDP ○ Allow the mixed team to now learn the entire EDP process. Guide the students through the What, So What, Now What protocol:	Day 1 - Activity 1 - Introduction to EDP - Subject Matter Expert Teacher Materials: Introduction to EDP - Subject Matter Expert Student Materials: Protocol: What So What Now What (WSWNW) **Teacher Actions:** • Synchronously using Zoom breakout rooms. Preplanning of break out rooms based on 3 person Working Groups and then mixed 7 person Discussion groups is recommended. • Divide the class into working groups of 2-3 persons. • Assign each team 1 of the EDP stages • Break the whole group into the working groups. • Allow the teams to learn the assigned EDP stage as a group and guide them through the What, So What, Now What protocol: • Pop-in and out of different groups to check progress of each group. **Student Actions:** • Will be in breakout rooms based on their Working Group. • Students will individually - Determine what their EDP stage means and be ready to answer the "What and So What?" Questions of their assigned EDP Stage. • Begin the WSWNW Discussion Protocol **Day 1 - Activity 2 - Discussion Groups - So What is the EDP?** **Teacher Actions:**

- Keep the chronological order of the EDP and allow the students to go through the protocol:

Student Actions:

- In order from start to finish of the EDP, each student will present their stage as the Subject Matter Expert (SME) - using the same What, So What, Now What Protocol.
- Begin the WSWNW Discussion Protocol
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Day 2 - Activity - Design and Build Challenge

Teacher Actions:

- Students start with a Formative Assessment Entrance Ticket to check their understanding of the EDP
- Students are grouped into their Working teams.
- Students will be challenged to design and build "The most slender paper tower" made from 10 sheets of regular paper and 1m of regular transparent gift wrapping tape.
- There will be a last-minute Design Change which will increase the difficulty of the challenge and simulate changes done in the field of Engineering Design
- Students will work through the mini 5e lesson plan - Design and Build: EDP Challenge

Student Actions:

- The student's goal is the apply the learned EDP to a design challenge to reinforce their understanding of the Engineering Design Process

- Using Zoom breakout rooms, divide the class again, this time into 2-3 discussion groups of 7 persons.
- Ensure that there is 1 SME representative for each stage of the EDP (based on previous group discussion activity)
- Assign each team 1 of the 7 steps of the EDP
  - Allow the mixed team to now learn the entire EDP process. Guide the students through the What, So What, Now What protocol:
  - Keep the chronological order of the EDP and allow the students to go through the protocol:

Student Actions:

- In order from start to finish of the EDP, each student will present their stage as the Subject Matter Expert (SME) - using the same What, So What, Now What Protocol.
- Begin the WSWNW Discussion Protocol

Day 2 - Activity - Design and Build Challenge

Teacher Actions:

- Students start with a Formative Assessment Entrance Ticket to check their understanding of the EDP
- Students will work at home individually to build their own towers but with the team's synchronous discussion and input using Zoom meeting.
- Students will be challenged to design and build "The most slender paper tower" made from 10 sheets of regular paper and

• Students will work through the mini 5e lesson plan - Design and Build: EDP Challenge	1m of regular transparent gift wrapping tape. • There will be a last minute Design Change which will increase the difficulty of the challenge and simulate changes done in the field of Engineering Design • Students will work through the mini 5e lesson plan - Design and Build: EDP Challenge **Student Actions:** • The student's goal is the apply the learned EDP to a design challenge to reinforce their understanding of the Engineering Design Process • Students will be instructed to determine their own schedule to meet as a working group. • Students will then work through the mini 5e lesson plan - Design and Build: EDP Challenge • Virtual modification - will be designing together using the mini 5e lesson plan but then building their own towers individually at home using the group's design specifications.

ELABORATION Engineering Design Process Choice Board

Classroom	Virtual
Teacher Actions: • The purpose of the Engineering Design Process Choice Board will be to assist in connecting the skill and content learning during the engagement, exploration, and explanation segments. • Choice Board: Provide an overview of the choice board for students so they may select resources to experience. The resources are meant to refine and secure student understanding of any concepts from previous segments on the topics of the EDP, scientific investigations, and the skills needed to produce a POM in the final evaluation segment. Teachers should highlight rubrics for guidance. **Student Actions:** • The goal is for students to demonstrate whether they understand the EDP or scientific investigation cycle and steps. • Choice Board: Work independently, in partners, or small groups of three to experience the choice board resources and complete the Assessment Ticket for feedback on understanding. Students should select resource experiences and options based on their level of understanding on the topics of the EDP, scientific investigations, and/or skills needed to produce a POM in the final evaluation segment. Rubrics should be used for guidance and quality.	**Teacher Actions:** • The purpose of the Engineering Design Process Choice Board will be to assist in connecting the skill and content learning during the engagement, exploration, and explanation segments. • Asynchronous: Video record synchronous instructions showing all resources and how to access the materials for student use. • Synchronous: Provide an overview of the Choice Board instructions and demonstrate the use of the hyperdocument links. **Student Actions:** • The goal is for students to demonstrate whether they understand the EDP or scientific investigation cycle and steps. • Choice Board: Work independently, in partners, or small groups of three in breakout sessions to experience the choice board resources and complete the Assessment Ticket for feedback on understanding. Students should select resource experiences and options based on their level of understanding on the topics of the EDP, scientific investigations, and/or skills needed to produce a POM in the final evaluation segment. Rubrics should be used for guidance and quality.

EVALUATION Written Proposal and Public Presentation

Classroom	Virtual
Teacher Actions: • Teacher will grade final POM written proposals using the eCybermission Scientific Inquiry or Engineering Design Rubric and this Template • Teacher will work together with students to prepare a presentation schedule with industry professionals if possible. **Student Actions:** • Students will write a polished Persuasive document modeling the Program Objective Memorandum and graded based on the eCybermission Scientific Inquiry or Engineering Design Rubric written in this Template format. • The information in the POM will then be presented in an approximately 10 minute or less presentation to an audience of industry professionals (if available). EXTENSION • If the student teams can be additionally challenged, then they will submit their research findings to one of the following two competitions depending on grade level. **Middle School** **eCybermission - Rules of Competition** **High School** **Junior Science and Humanities Symposium - Rules of Competition**	**Teacher Actions:** • Teacher will grade final POM written proposals using the eCybermission Scientific Inquiry or Engineering Design Rubric and this Template • Teacher will work together with students to prepare a presentation schedule with industry professionals if possible. This will be done synchronously virtually via Zoom if possible. Another option would be the students recording a 10 minute video recording for asynchronous viewing. **Student Actions:** • Students will write a polished Persuasive document modeling the Program Objective Memorandum and graded based on the eCybermission Scientific Inquiry or Engineering Design Rubric written in this Template format. • The information in the POM will then be presented in an approximately 10 minute or less presentation to an audience of industry professionals (if available). If scheduling and technology is not conducive then the option to record a 10 minute or less video presentation which will be viewed asynchronously. EXTENSION • If the student teams can be additionally challenged, then they will submit their research findings to one of the following two competitions depending on grade level. **Middle School** **eCybermission - Rules of Competition** **High School** **Junior Science and Humanities Symposium - Rules of Competition**

APPENDIX

APPENDIX RESOURCE

Next Generation Science Standards (NGSS)

Performance Standards - High School Engineering Design

Performance Standards - Middle School Engineering Design

Engage Resources

Military Gallery Teacher & Student Classroom/ Virtual Class Slides

Level 1, 2, 3, and 4

Padlet or Slide

Military Gallery Student Interactive Notebook or Handout

Level 1, 2, and 3

Explore Resources

Station 1 Video review of Dr. Troy Alexander and Worksheet

Station 2: Card sort - Engineering Problems and Solutions matching

Station 3: Websearch - Warfighter Technologies

Station 4: Engineering design Guide with Worksheet

Explain Resources

Day 1 Introduction to EDP - Subject Matter Expert

Day 2 Formative Assessment Entrance Ticket

Day 2 mini 5e lesson plan - Design and Build: EDP Challenge

Engineering Design Process

EDP - Introduction Video

Elaborate Resources

Engineering Design Choice Board

Assessment Ticket

Evaluate Resources

Middle School - eCYBERMISSION

Step 1. Instructions Project Objective Memorandum (POM)

Instructions

POM Notes

POM Template

Step 2. POM Research Question

PBL Works Writing a Driving Question

Lotus Blossom

Step 3. POM Engineering Design (ED) and Science Inquiry (SI) Support

SI and ED Blank Handout

SI Timeline

ED Timeline

Step 4. POM Media - Report, Storyboard, Video

POM Sample

POM Template

Storyboard Sample

Storyboard Template

Step 5. Presentation or eCYBERMISSION

Project Presentation

eCYBERMISSION Rubric

High School - Junior Science and Humanities Symposium

(Step 1-4 from Middle School - eCYBERMISSION

Step 5. Presentation, eCYBERMISSION, and/or JSHS