**Exploratory Design 5/6**

**Course Overview and Outline**

12 Week Course

Meets 3 days in 6

Maximum Days: 36 days (Approximately 30 instructional days)

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**COURSE DESCRIPTION**

Exploratory Design 5/6 is currently under development and is a two-progression course for students in grades 5 and 6. Students will take one 12-week course of Exploratory Design in 5th grade followed by a second 12-week class in the 6th grade. The 6th grade version of the course will build on skills and concepts developed in Exploratory Design 5. However, the first year, the two courses would be similar as the students taking Exploratory Design 6 would not have the benefit of prior years’ experience.

This hands-on exploratory class takes a thematic approach to the presentation and solution of problems. Students are formally introduced to problem-solving processes from the fields of computer science, engineering, and science as they seek to develop products and models that address a specific set of problems. Students work with a set of guiding processes drawing from Design Thinking, Engineering and Design, Computational Thinking and Next Generation Science Processes. These guiding processes are listed at the end of this document.

Using these guiding processes, students use collective research, systems modeling and computational representations along with the building of physical artifacts that represent their understanding of the problem and possible solutions. The class is a collaborative environment encouraging students to freely share their thoughts and insight with their peers as they work through the various challenges.

Students are expected to work on increasingly more complex problems as the trimester progresses and present their groups’ work during the final week of classes each trimester. As students work through their problems, they will work with several different learning tasks that serve as artifacts of understanding produced throughout the course. These are found below:

**Learning Task Categories**

1. Invent something
2. Build something
3. Model something
4. Deconstruct something

It is expected that each trimester will focus on problems related to a specific theme. We have proposed preliminary themes for next year. The first trimester, grades 5 and 6 will be working on similar problems but based in different narratives. Classes taking the course second trimester would focus on solutions to problems related to feeding the world. The third trimester classes would address issues related alternative energy. Below, you will find the proposed first year sequence, a sample course sequence, possible themes for the first year, and a list of guiding processes.

**FIRST YEAR SEQUENCE**

**Trimester 1**

Exploratory Design 5: Mission to Mars

Exploratory Design 6: The Deep Abyss

**Trimester 2**

Exploratory Design 5: Feeding the World

Exploratory Design 6: Feeding the World

**Trimester 3**

Exploratory Design 5: Energy for All

Exploratory Design 6: Energy for All

**SECOND YEAR SEQUENCE**

The second year sequence can be adjusted to account for the 6th graders who will have prior experience in the class. This will open up new themes and more sophisticated problems.

**SAMPLE COURSE SEQUENCE (Year 1)**

**Unit 1- Introduction**

2 Weeks (6 days)

Introduction to collaborative problem solving and the course theme.

Students are introduced to collaborative problem solving techniques and the guiding processes through exploration of two simple problems. These problems are not related to the course theme and are designed to help students begin to work systematically as teams. They will also start to research concepts surrounding the trimester theme.

Example of an introductory problem might include the challenge of measuring a physical space with non-standard units and building a scaled 3D model from paper. They would then develop a simple computer program that will convert their non-standard units to any standard measuring system.

**Unit 2- Problem 1**

3 Weeks (9 days)

The nature of this unit is dependent on the theme. Of the three theme based problems presented, this will be the easiest to address.

**Unit 3- Problem 2**

3 Weeks (9 days)

The nature of this unit is dependent on the theme. Of the three theme based problems presented, this will be of medium difficulty

**Unit 4- Problem 3**

4 Weeks (12 days)

The nature of this unit is dependent on the theme. Of the three theme based problems presented, this will be the most complex. Additionally, student groups will present their trimesters’ work during the last week of class.

**POSSIBLE THEMES**

**Mission to Mars**

This theme explores various aspects related to a mission to the planet Mars and considers travel as well as scientific exploration. Students will explore the problems related to exploration in remote inhospitable places and propose solutions that will help them learn more about this remote planet.

**Possible Subtopics**

1. Remote sampling
2. Remote sensing
3. Remote control
4. Communications
5. Contamination

**The Deep Abyss- The Final Frontier**

Space is often referred to as the final frontier. However, there is a place on Earth that equals space in remoteness and complexity related to its exploration, and it is only a “dip” away. The deep ocean presents many of the same types of challenges as deep space exploration. This theme gives students a chance to develop ways to explore places we can’t go or see and probe the deepest most remote places on earth.

**Possible Subtopics**

1. Remote sampling
2. Remote sensing
3. Remote control
4. Communications
5. Pressure
6. Contamination

**Feeding the World**

There is more than enough food to feed everyone in the world. Yet, many in the world are malnourished and go hungry. Working with simulations and modeling, this theme allows students to explore this problem and develop possible solutions.

**Possible Subtopics**

1. Remote Sensing
2. Problems of Distribution
3. Storage and Production
4. Modeling complex systems

**Energy for All**

There is no shortage of energy in the world if we are open to new ways of harnessing the energy that reaches the earth’s surface every day. Working through a series of problems related to solar, wind, and tidal energy, students will explore solutions to maximizing energy output through experimentation, simulation and building projects.

**Possible Subtopics**

1. Problems of Wind Generation
2. Problems of Solar Generation
3. Problems of Tidal Generation
4. Energy Storage
5. Modeling complex systems

**GUIDING PROCESSES**

**Design Thinking Process**

1. Understand
2. Observe
3. Define
4. Ideate
5. Prototype
6. Test

**Engineering Design Process**

1. Identify the Problem
2. Brainstorm Possible Solutions
3. Generate Ideas
4. Explore Possibilities
5. Select an Approach
6. Build a Model or Prototype
7. Refine the Design

**Eight Practices of Science and Engineering** (from Next Gen. Science Standards)

1. Asking questions and defining the problem
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations and designing solutions
7. Engaging in argument from evidence
8. Obtaining, evaluating and communicating information.

**Computational Thinking**

1. Decomposition
2. Pattern Recognition (recursion, iteration)
3. Pattern Generalization and Abstraction
4. Algorithm Design

**Middle School Computer Science Objectives**

**Objectives**

The student will:

**A- Computational Thinking**

1. Understand and use the basic steps in algorithmic problem-solving (e.g., problem statement, and exploration, examination of sample instances, design, implementation, and testing).
2. Develop a simple understanding of an algorithm (e.g., search, sequence of events, or sorting) using computer-free activities.
3. Evaluate what kinds of problems can e solved using modeling and simulation

**B- Collaboration**

1. Use online resources (e.g., email, online discussions, collaborative web environments) to participate in collaborative problem solving activities for the purpose of developing solutions or products.
2. Collaborate with peers, experts and others using collaborative practices such as pair programming, working in project teams, and participating in group active learning activities.
3. Collaboratively design, develop, build, publish, and present products (e.g., videos, podcasts, websites) using technology resources that demonstrate and communicate cross curriculum concepts.

**C- Computing Practice and Programming**

1. Contextually use productivity technology tools (e.g., word processing, spreadsheet, presentation software) for individual and collaborative writing, communication and publishing.
2. Implement problem solutions using a programming language such as Scratch, Python or Alice. Programming skills include looping behavior, conditional statements, logic, expressions, variables and functions.
3. Interact with content-specific models and simulations (e.g., ecosystems, epidemics, molecular dynamics) to support learning and research.

**D- Community, Global and Ethical Impacts**

1. Identify the impact of technology including social networking, cyber bullying, and cyber security on personal life and society.
2. Evaluate the accuracy, relevance, appropriateness and biases that occur in electronic information sources.

**Next Generation Science Standard Practices Grade 5**

**N1. Asking Questions and Defining Problems**

1. Identify scientific and non-scientific questions
2. Ask questions based on careful observations of phenomena and information
3. Ask questions to clarify ideas or request evidence
4. Ask questions that relate one variable to another variable
5. Ask questions to clarify the constraints of solutions to a problem
6. Use prior knowledge to describe problems that can be solved
7. Define simple design problems that can be solved through the development of an object, tool or process and includes several criteria for success and constraints on materials, time or cost.
8. Formulate Questions that can be investigated and predict reasonable outcomes based on patterns such as cause and effect relationships

**N2. Developing and Using Models**

1. Develop and revise models collaboratively to measure and explain frequent and regular events
2. Develop a model using an analogy, example or abstract representation to describe a scientific principle or design solution
3. Use simple models to describe or support explanations for phenomena and test cause and effect relationships or interactions concerning the functioning of a natural or designed system.
4. Develop a diagram or simply physical prototype to convey a proposed object, tool or process.
5. Use a simple model to test cause and effect relationships concerning the functioning of a proposed object, tool or process.

**N3. Planning and Carrying Out Investigations**

1. Design and conduct investigations collaboratively, using fair tests in which variables are controlled and the number of trials considered.
2. Evaluate appropriate methods and tools for collecting data
3. Make observations and or measurements, collect appropriate data and identify patterns that provide evidence for an explanation of a phenomenon or design a test solution.
4. Make measurements of two different models of the same proposed object, tool, or process to determine which better meets criteria for success.

**N4. Analyzing and Interpreting Data**

1. Display data in tables and graphs using digital tools when feasible to reveal patterns that indicate relationships
2. Use data to evaluate claims about cause and effect
3. Compare data collected by different groups in order to discuss similarities and differences in their findings
4. Use data to evaluate and refine design solutions
5. Interpret data to make sense of and explain phenomena, using logical reasoning, mathematics and/or computation
6. Analyze data to refine a problem statement or design a proposed object, tool or process.

**N5. Using Mathematics and Computational Thinking**

1. Use mathematical thinking and/or computational outcomes to compare alternative solutions to an engineering problem
2. Organize simple data sets to reveal patterns that suggest relationships
3. Describe, measure, estimate, and graph quantities such as area, volume, weight, and time to address scientific and engineering questions and problems.
4. Decide if qualitative or quantitative data is best to determine whether a proposed object or tool meets criteria for success.

**N6. Constructing Explanations and Designing Solutions**

1. Construct Explanations of observed quantitative relationships
2. Use evidence to construct a scientific explanation or design a solution to a problem
3. Identify the evidence that supports particular points in an explanation
4. Distinguish among facts reasoned judgments based on research findings and speculation in an explanation
5. Apply scientific knowledge to solve design problems
6. Generate and compare multiple solutions to a problem based on how well they meet the criteria and constraints of the problem.

**N7. Engaging in Argument from Evidence**

1. Construct and or support scientific arguments with evidence, data and or a model
2. Compare and refine arguments based on the strengths and weaknesses of the evidence presented.
3. Respectfully provide and receive critiques on scientific arguments with peers by citing relevant evidence and posing specific questions.
4. Make a claim about the merit of a solution to a problem by citing relevant evidence about how it meets the criteria and constraints of the problem.

**N8. Obtaining, Evaluating and Communicating Information**

1. Compare and combine across complex texts and other reliable media to acquire appropriate scientific and technical information.
2. Determine the main idea of a scientific text and explain how it is supported by key details: summarize the text
3. Combine information in written text with that contained in corresponding tables, diagrams and charts
4. Use multiple sources to generate and communicate scientific and or technical information orally and in written formats including various forms of media.
5. Use models to hare findings or solutions in oral and written presentations or extended discussions.
6. Obtain and combine information from books and or other reliable media about potential solutions to a specific design problem.