Deer Valley Unified School District

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Boulder Creek High School
CTE & Academic Integration

CAREER AND TECHNICAL EDUCATION
BCHS CTE

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Boulder Creek High School **Integrated Academics**

CTE Course: *Principles of Engineering*

Academic Course(s): *Physics*

Unit Name: *Robotic Programming and Design*

Lesson Name: *Super Speedy Robots*

Lesson Synopsis: *Engineering students are given an opportunity to apply problem solving and data collection skills to design a robot that will meet the needs of the "customer". The "customer" will ask each engineering design team to program a robot that will move in a straight line at a certain speed. The design teams will be required to collect and analyze time and distance data to determine the speed of the robot and make adjustments to it's programming and/or design in order to meet the needs of the customer. The data collection and analysis skills are learned and applied in Physics courses on campus.*

Time Frame:

CTE Course – 2 weeks

Academic Course(s) – 2 Weeks

Objectives:

CTE Course –

The student will design, program and build a robot that will move in a straight line at a given speed.
The student will modify and refine necessary design and programming to meet the design specifications.

Academic Course(s) –

The student will collect time and distance data for the robot using appropriate tools.
The student will use graphical methods to analyze time and distance data of the robot.
The student will derive the speed of the robot from the graphical analysis of time and distance data.

Standards:

CTE Course –

Engineering Sciences: PO 2.1-Apply a structured approach to solving problems including: defining a problem (including customer needs), brainstorming, researching and generating ideas, identifying criteria and constraints, exploring possibilities, making a model (physical, mathematical, conceptual), evaluating the solution using standards and specifications (i.e., testing), and communicating results
Engineering Sciences: PO 2.6-Develop and implement a plan for a project (i.e., time, materials, resources, and steps)
Engineering Sciences: PO 4.1-Apply appropriate data collection and analysis methods to display data (graphs, tables, formulas, and words)
Engineering Sciences: PO 4.5-Apply mathematical concepts to modeling

Academic Course(s) –

Strand 1: Concept 2-PO 3. Design an appropriate protocol (written plan of action) for testing a hypothesis:

- *Identify dependent and independent variables in a controlled investigation.*
- *Determine an appropriate method for data collection (e.g., using balances, thermometers, microscopes, spectrophotometer, using qualitative changes).*
- *Determine an appropriate method for recording data (e.g., notes, sketches, photographs, videos, journals (logs), charts, computers/calculators).*

Strand 1: Concept 2-PO 5. Record observations, notes, sketches, questions, and ideas using tools such as journals, charts, graphs, and computers.
Strand 5: Concept 2-PO 1. Determine the rate of change of a quantity (e.g., rate of erosion, rate of reaction, rate of growth, velocity).

Strand 5: Concept 2-PO 2. Analyze the relationships among position, velocity, acceleration, and time:

- *graphically*
- *mathematically*

Bloom's Taxonomy

☒ Knowledge	☒ Application	☒ Synthesis
☒ Comprehension	☒ Analysis	☒ Evaluation

Resources & Materials:

CTE Course –

VEX Robot
PC with Microsoft Excel

Academic Course(s) –

Masking Tape
Stop Watches
PC with Microsoft Excel

Prerequisite Learning:

CTE Course –

**Data collection with appropriate units*
**Robot Programming and building*
**Whiteboards for each group*

Academic Course(s) –

**Graphical analysis*
**Definition of speed*

Learning Structures/Strategies

CTE Course

Set for Interest
Engineering "design teams (students)" are approached by the "customer(teacher)" and asked to build a robot that goes in a straight line at a certain speed. The design teams will be given the robot and the necessary data collection tools to complete the process.

Input/Modeling
The initial phase(1 week) of this 2 week project requires the design team to first build the robot and make sure that it is functional. The robot will be of a variety that will allow it to move in a straight line at a constant speed and will allow for speed modification either through programming or mechanical changes to the robot.
The 2nd phase of the project will include the testing and modification of the robot to meet the "customer's" specifications. The testing phase will consist of collecting distance and time data for the robot then analyzing that data to determine the speed of the robot.

Check for Understanding
The teacher will have each design team use a whiteboard to begin initial brainstorming regarding the data collection phase. The design teams will be asked to identify ways of collecting data to determine the speed of the robot. The students should identify things such as measuring out a "track" and collecting time data at each distance. The teacher should guide a discussion between design teams to develop a standardized way to collect accurate data. Guidelines should include placing tape on the ground in 1 meter increments, collecting time data at each meter mark, running multiple trials, and minimizing error.

Guided Practice
The opportunity for Physics integration into the engineering classroom centers around scientific process of collecting and analyzing distance and time data to determine the speed of objects. Since many students will not have been exposed to this process the class will need to have practice regarding the necessary data analysis skills. To start the 2nd phase of the project students will be given data sets that they will graph using Microsoft Excel. They will learn how to graph the data and then use regression statistics within the program to find the slope. The slope of the data collected specifically for the robots will tell the students the speed of the robot.

Independent Practice
In order to practice collecting data and graphing that data for analysis, students will have homework that will include collecting their own data and graphing that data. They can be given much leeway on what they choose but they must identify what variables they are measuring and why. The resulting graph must show the relationship that was tested and what the final results are.

Closure
The data collection and robot modification process will be the most beneficial learning period during this 2 week project. Design teams will most likely need to collect and analyze speed data for their robots several times before they modify the robot to the requisite speed. Students will record the data collected for each trial, save copies of the derived graphs, and write a conclusion for each trial that specifies whether the robot met the criteria, why it did or didn't and what modifications will be necessary to allow the robot to meet the requirements on the next trial.

Assessment
The final assessment will consist of 2 parts. The first part will consist of a full lab report showing the data and trials each design team collected and a final analysis of that data including a full report of the robot's performance. The 2nd part of the final assessment will be a lab practicum where each design team will "present" their robot to the "customer". The design team must explain the design process and then demonstrate that the robot meets the requirements indicated at the start of the project.

Learning Structures/Strategies

Sequence

Day 1-5
Students will be constructing the robots during the first week in class. They will build and program the robot and make sure that it is functioning and operable.

Day 6
On the first day of the 2nd week students will brainstorm and collaborate on data collection methods and prepare for data collection and testing.

Day 7
Students are given data sets and shown how to use Excel to analyze those data sets and derive the slope. Homework will be an assignment where students collect and analyze data on their own.

Day 8-9
Design teams begin collecting distance and time data for their robots. Once this data is collected it is entered and analyzed using Microsoft Excel to determine the speed of the robot. Teams will need to modify and retest until they meet the specified requirements given to them by the "customer".

Day 10
The final day will consist of design team presentations and demonstrations. The robots will be graded on their ability to move in a straight line at the given speed. Design teams will submit their final report.