High Performance Math

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Abstract

HiPer Math is a very new program developed to teach California Content and Occupational Educational Standards –in math and science through hands on automotive engine dismantling and assembling, virtual drag racing and math competitions. There are lesson plans for over 60 standards (more to come) with the availability of custom lesson plans available to meet the needs of any student group.

HiPer Math is an innovative teaching design using virtual online models of racing cars getting students to use math applications in competitive solutions to maximize the design and operation of these virtual vehicles. Through the use of virtual and hands-on devices students design engines (bore, stroke, compression), fuel/air mixtures (carburetors), transmissions (gear and power ratios), tires and wheels (power and speed), body design (air drag and slip) and many other automotive functions using equations and problems based at their level of learning algebra, geometry, trigonometry, through to calculus.   Projects are multi-dimensional allowing classes to integrate science, engineering, mathematics, and automotive design.

Introduction

A 21st Century Education calls for rigor and relevance with the engagement of students in addressing real world issues. With our national math proficiency test scores so low, HiPer Math was designed to bring the relevance of math, from algebra through calculus, alive through virtual drag racing and math competition on the World Wide Web. HiPerMath is unique because it couples rigorous math standards with the excitement of racing. Students access the HiPerMath web site to investigate the science of car and engine design. Students then engineer their cars by performing math calculations.

When their car is completed to their satisfaction, the students race on a virtual racetrack. The virtual racetrack is on a racing machine that looks like a video game complete with steering wheel, gearshift and gas and brake pedals. The racing machine was built to respond to even the smallest changes students make to their engines and cars. During the competition, students see the performance of other students' cars and respond by improving their own car. The math portion of the competition involves a standards-based lesson and exercises related to racing.

Background

HiPerMath invested 2 years in the development of a highly accurate algorithm for the calculation of engine horsepower and torque. The algorithm is based on air mass flow and real world engineering equations. When a student designs an engine with certain specifications that produces certain horsepower and torque numbers on HiPerMath, that engine design is capable of

producing the same horsepower and torque in the real world. By researching hundreds of street cars and factored in: engine horsepower, engine torque, engine size, turbocharges, superchargers, tire size, gearing, weight, center of gravity (cg) and more to create the most accurate virtual drag race possible.

HiPerMath also developed a virtual racetrack which accurately simulates the performance of the racecars the students build. If a racecar were developed in the real world with the specifications of the virtual car the students design, its real world performance would be very close to the simulation. This high level of real world accuracy was accomplished through much research and consultation with fluid dynamics engineer, Gordon Short, and drag race car builder and driver, Dave Meigide.

The program can be integrated into classroom instruction, before, during lunch or after school periods, or even a weekend event. Due to the fun that students have and the healthy competition that develops between them most will go home to continue their search for the fastest car once again reinforcing the math concepts with a real world context. All they need is access to a computer with internet capabilities.

This novel way of teaching concepts in geometry, algebra, trigonometry and calculus allows for students to learn more at their own pace. HiPer Math is designed for the student that wishes to explore on their own to be able to do so. Each exercise has questions the student answers to earn competition points. The questions are similar to those found on the California High School Exit Examination (CAHSEE) and there is a specific module for CAHSEE practice questions.

Methodology

Currently HiPerMath is beta testing in a variety of middle and high schools in the Inland Empire (San Bernardino and Riverside counties in California).

A pre test and post test (using CAHSEE practice questions designed around drag racing) is administered in each module.

Current programming is being done to track the time each individual student and each class spends on designing their car and engine, both in class and out of class.

With the start of the next academic school year 2011 – 2012 HiPer Math will be working with a specific school district to implement the program in a middle school as an after school project. Using STAR testing results and classroom performance assessments both formative and summative up through and including algebra and geometry, we will compare the after school HiPer Math group with a matched group not participating in HiPer Math.

Summary

Although still in the test phases an example of the results from 15 minority middle school students (male and female) showed average correct pretest score of 1%. Average posttest score of 69% and based on individual student data from specific questions, 100% of the students learned to calculate the volume of a cylinder and some learned to convert to liters. A female took third place in the overall competition.

HiPerMath is committed to taking math, engineering and technical learning beyond the textbooks and rows of desks. Today's learner demands a more tailored approach with meaningful opportunities to learn both the standards and their relevancy to the tangible world.

References

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Authors Information

Wendy Zinn is the Program Manager of the CTE Community Collaborative Gran at the San Bernardino Community College District. Ms. Zinn develops and implements programs for five school districts within the San Bernardino County. She was a Program Coordinator, at California State University – San Bernardino, for a federally funded GEAR UP grant that served 3,600 underserved students in four Southern California school districts.

Craig Reisgen is the owner and developer of High Performance Math, an online math and racing competition. He has a degree in developmental psychology and mathematics. Mr. Reisgen was a substitute teacher and home and hospital teacher at Rim of the World School District, Lake Arrowhead, CA. He has been a program director at Club Wilderness, a Boys and Girls Club of Hollywood camp, which used to be located in the San Bernardino Mountains.