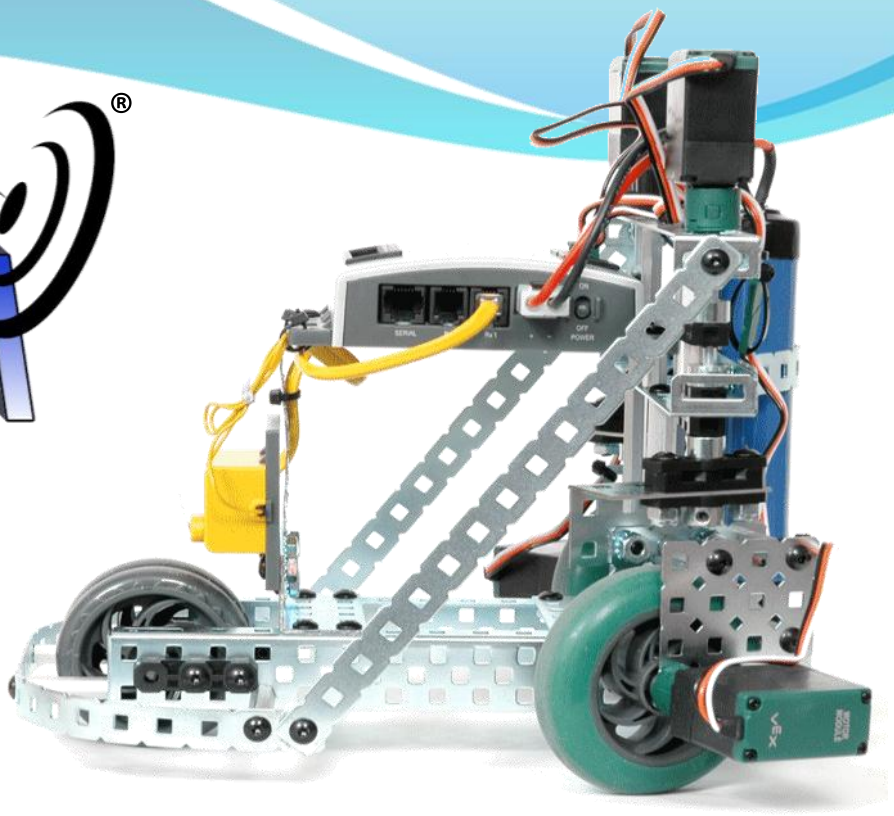
AIM®
ANALYTICAL INTEGRATED MATH



Engineering Math in Texas High Schools

WACO INDEPENDENT SCHOOL DISTRICT

TSTC Texas State Technical College

DAVINCI MINDS

TSI

intelitek

VEX ROBOTICS DESIGN SYSTEM

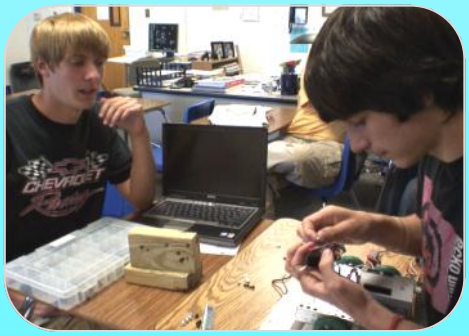
GEAR UP WACO

www.texasaim.com

ANALYTICAL INTEGRATED MATH

AIM is a 12th grade math course taught using exploratory learning. Students learn and apply math concepts using the mechanical engineering, electrical engineering, and computer programming required to build a robot that meets design challenges.

Students who complete AIM are better prepared for college entrance tests and college-level math.



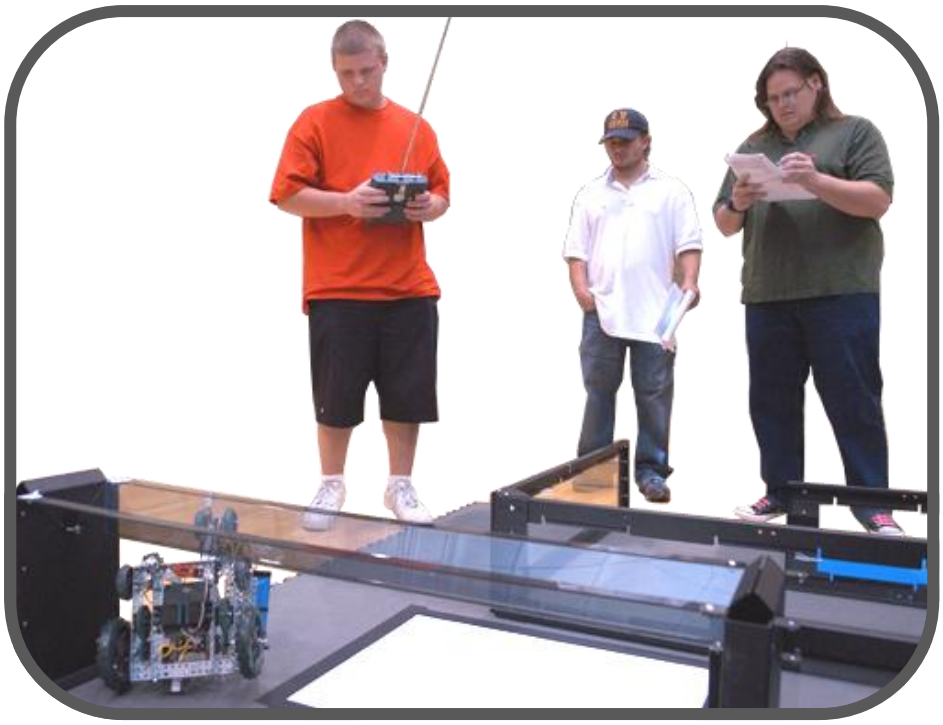
About AIM

The Texas Legislature updated the Texas Education Code in 2007. It now requires secondary school students to complete four years of math and science. This law, nicknamed the *4x4*, has driven demand for additional math curricula within the state. This question follows: *For those students who would not have taken math in their senior year, what math should they learn?*

AIM is an Engineering Math course specifically designed for the jobs revolution already taking place in America. AIM students experience a rich blend of math disciplines, combined with principles of engineering, while providing the rigor and relevance needed in a high school senior math course.

AIM meets the requirements for Engineering Mathematics as defined by the Texas Essential Knowledge and Skills (TEKS) state education standards.

The AIM program is producing more college-ready students and preparing students for career pathways previously not accessible to many Texas high school students.



ANALYTICAL INTEGRATED MATH

Nearly half the 14.7 million undergraduates at two- and four-year institutions never receive degrees.

2006, New York Times

The annual cost of community college remediation is estimated to be $1.4 billion nationally.

2006, Alliance for Excellent Education

Colleges are overwhelmed with students needing remedial classes in math. The problem is becoming so large that colleges are forced to rewrite textbooks, do more re-teaching, and even force students to take remedial courses without credit.

Barbara Pytel, Suite101.com

History of AIM

Texas State Technical College (TSTC) had a problem. The cost of remediation was staggering, consistent with the experience of the other 1,200 two-year colleges across the country. What was the culprit? *Math.* Numerous studies indicate that mathematics, specifically logical and abstract thinking skills, are an important gateway to student success.

In 2006, partnering with neighboring Waco Independent School District, a team of dedicated educators began to develop a course that would improve college entrance exam scores for graduating high school seniors, and reduce the cost of remediation. The result of their efforts was named *AIM - Analytical Integrated Math*.

Donna McKethan—Waco ISD AIM champion; CTAT Texas Administrator of the Year, 2010

2006 A six year Federal grant program, GEAR UP, is created to better prepare students for post-secondary education. The Texas GEAR UP grant becomes the funding mechanism for the development of AIM.

2007 The Baylor University CASPER program, Texas State Technical College (TSTC), and Waco ISD are the GEAR UP grant recipients. They develop the curriculum for the course.

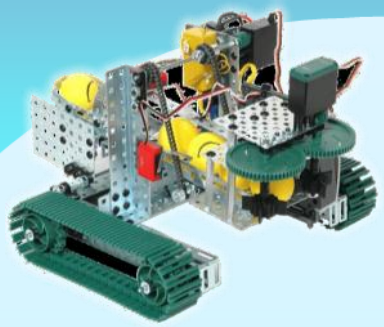
DaVinci Minds, Inc. designs a customized kit using VEX Robotics parts and components, to facilitate construction of the robots used in the course.

Intelitek, a training system provider, along with Texas reseller TSI, provides the online platform for hosting the curriculum that students access in the classroom.

2008 AIM is introduced to 10 classrooms, 210 students, in the Waco ISD.

2010 More schools adopt AIM.

2011 AIM has expanded to 22 Texas schools.



TEKS 130.367 Knowledge and Skills

(1) The student uses mathematically based hydraulics concepts to measure and find pump output, understand pressure versus cylinder force, and understand flow rate verses cylinder speed.

(2)The student uses mathematical concepts of structure design to define and describe statics, acquire data, apply concepts of moments and bending stress, and apply concepts of truss design and analysis.

(3) The student understands the properties of trigonometry in spatial applications.

(4) The student understands the concepts of design processes with multi-view computer-aided drafting and design drawings for facilities layouts, precision part design, process design, computer-aided manufacturing for lathe, and injection mold design.

(5) The student calculates electronic quantities and uses electrical measuring instruments to experimentally test their calculations.

(6) The student applies mathematical principles of pneumatic pressure and flow to explain pressure versus cylinder force, apply and manipulate pneumatic speed control circuits, and describe maintenance of pneumatic equipment, centrifugal pump operation and characteristics, data acquisition systems, pump power, and pump system design.

(7) The student applies mathematical principles of manufacturing processes in lathe operations and computer numerical control mill programming and calculates speeds and feeds for machining tools, including special cutting tools.

(8) The student applies mathematical principles of material engineering, including tensile strength analysis, data acquisition systems, compression testing and analysis, shear and hardness testing and analysis, and design evaluation.

(9) The student applies mathematical principles for mechanical drives, including levers, linkages, cams, turnbuckles, pulley systems, gear drives, key fasteners, v-belt drives, and chain drives.

(10) The student applies mathematical principles of quality assurance, including using precision measurement tools, statistical process control, control chart operation, analysis of quality assurance control charts, geometric dimensioning and tolerancing, and location, orientation, and form tolerances.

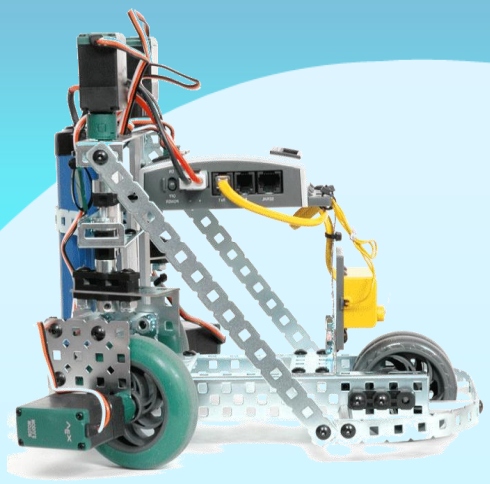
(11) The student applies mathematical principles of robotics and computer programming of robotic mechanisms in point-to-point assembly, calculating working envelope and computer system conversions.

What is Engineering Math?

In 2010, Texas Essential Knowledge and Skills were updated to include a new core academic course called *Engineering Math*. AIM meets the TEKS for Engineering Math, as outlined in the sidebar. AIM, during its pilot period as an officially designated *innovative course*, contributed substantially to the definition of the Engineering Math TEKS.

The introduction to TEKS 130.367 reads as follows:

"Engineering Mathematics is a course where students solve and model robotic design problems. Students use a variety of mathematical methods and models to represent and analyze problems involving data acquisition, spatial applications, electrical measurement, manufacturing processes, materials engineering, mechanical drives, pneumatics, process control systems, quality control, and robotics with computer programming."



Program Founder and K-12 Partner

Postsecondary Partner

First Point of Contact, Robot Kits, Installation, Training and Support

Curriculum & Online Learning System Sales, Installation and Training

Online Learning System and Curriculum

Robots Provided by

Original development funded by

GEAR UP WACO

A Turnkey Solution for Engineering Math

The AIM program and curriculum has everything you need to guide your students, train your teachers, prepare your classrooms, and keep your program running smoothly through the school year.

AIM Curriculum	The AIM curriculum is the online content—the lessons, reviews, quizzes and tests—that guide students through the course.
The Online Learning System	The LearnMate Learning Management System is at the center of the student's interactive learning experience. Students log on to access their lessons, take quizzes and tests, and upload assignments for evaluation.
Educational Robots	Educational robots bring the mathematics learning experience to life in real world applications. Robots are kitted specifically for use in AIM high school classrooms.
Teacher Professional Development	Teachers attend a one-week class taught by AIM developers. A teacher must be either math- or CTE-certified in order to attend the training and teach AIM. Course instructors guide teachers through the AIM curriculum in one week.
Installation & Support	All equipment and software is quickly and professionally installed so that your teachers and classrooms are ready to start the first day of class. Ongoing support is provided for hardware, software and program needs.
Community Of Practice	A sustaining Community of Practice fosters open communication among AIM teachers, schools, and school district personnel.

By 2012, over 40% of factory jobs will require post-secondary education. Nearly half of all 17-year-olds do not have the basic understanding of math needed to qualify for this requirement.

2005, The Looming Workforce Crisis, National Association of Manufacturers

Jobs requiring math are increasing four times faster than overall job growth.

Raytheon Company survey

LearnMate®

The LearnMate® Learning Management System from Intelitek provides students with a multi-media interactive learning experience. LearnMate was chosen specifically for AIM due to its content management system and the ability to bring content to life for students.

Content

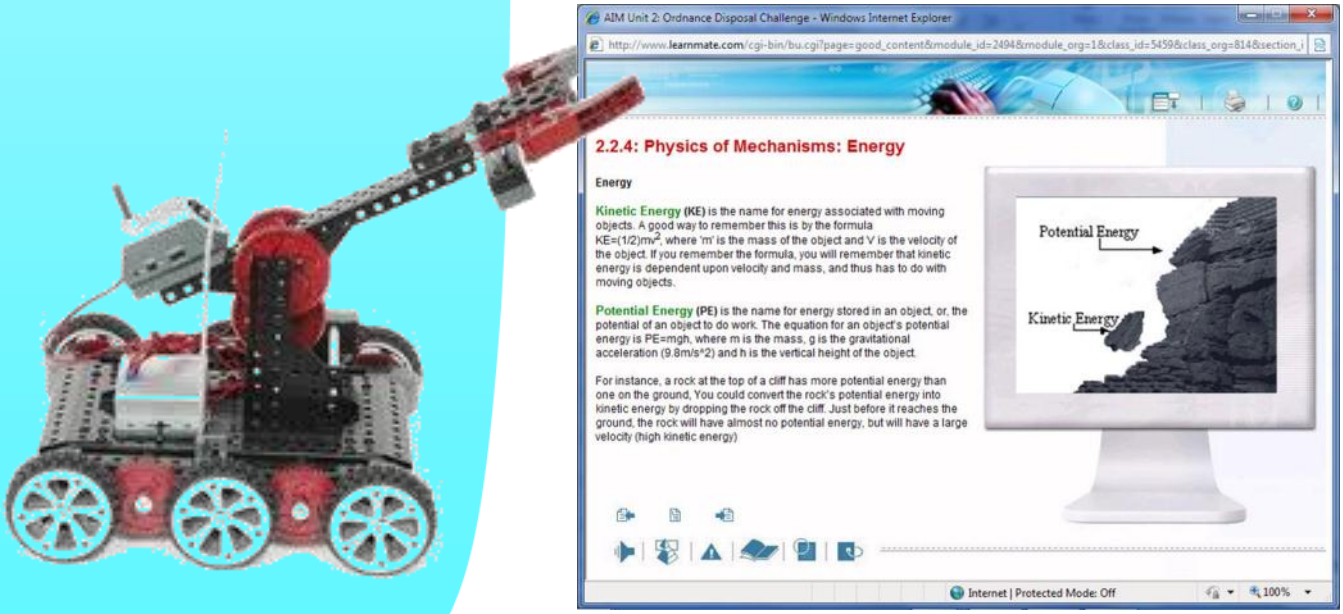
The LearnMate online learning system is designed specifically to engage the student by delivering content in an interactive and organized manner. The graphical user interface has a consistent look and feel, and an intuitive navigation methodology complete with screen tips and help screens, all within a multimedia environment.

Videos and Animation

LearnMate curriculum includes videos and animations in course content. In addition, many content pages are narrated. Students control the audio using an icon on the content page.

Embedded Assignments

Embedded quizzes and tests can quickly gauge students' competencies in Engineering Math concepts and applications. Teachers can identify problematic areas and direct students to supplementary lessons.



The Challenges

In all challenges, quality of the design, safety design consideration, performance/operation, workmanship, proof of planning (Engineering Design Notebook), team presentation, and bill of materials are graded.

Unit 1 – Bridge Engineering Challenge

Using West Point Bridge Designer Software, students learn problem solving using engineering principles.

Students build a bridge with spaghetti, masking tape and hot glue.

Unit 2 – Ordnance Disposal Challenge

Students must design/build a robot capable of traveling 20', pick an ordnance object up, and dispose of the ordnance.

Unit 3 – Robot Soccer Challenge

In this challenge, students program the robot to be able to "kick" a tennis ball into a goal within the VEX arena using at least one pneumatic cylinder.

Unit 4 – Three Kilogram Lift Challenge

Using the concepts learned in the AIM course, students are asked to create a new robot or modify their current robot to be able to lift a 3 kg weight from one corner of the VEX arena and transport the weight around obstacles to the opposite corner. The weight must not touch the arena floor while being transported.

Unit 5 - Autonomous Navigation Challenge

Students must design and build a motor powered robot that uses sensors to navigate a specific maze autonomously, sense a white block of paper on the arena floor, stop and do a "victory dance" consisting of four separate movements.

Unit 6 - Final Challenge – Robotics Competition

Design and build a motor powered robot that navigates a specific maze autonomously and then complete a set of tasks by remote or autonomous control.

The Final Challenge encompasses eight weeks of intense competition.

The Units

The AIM course is divided into six units:

1. **Bridge Engineering Challenge – Weeks 1-4**
   - Getting Started with LearnMate
   - Introduction to Robotics
   - Construction Technology

2 – **Ordnance Disposal Challenge – Weeks 5-8**
   - Mechanisms
   - Mechanical Measurements and Quality Control
   - Mathematics for Technicians I
   - The VEX Robot

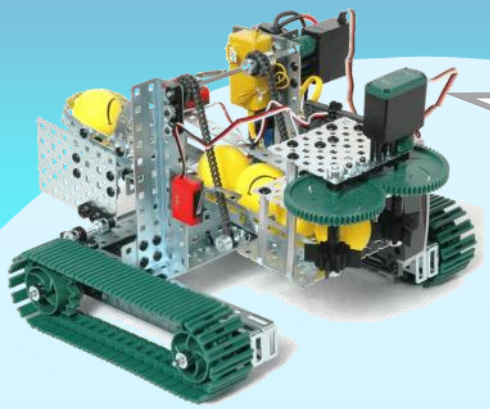
3 – **Robot Soccer Challenge – Weeks 9-17**
   - Intro to VEX Programming
   - Machine Vision and Image Processing
   - Mathematics for Technicians II
   - Hydraulics Technology I
   - Pneumatics Technology I

4 – **Three Kilogram Lift Challenge – Weeks 18-21**
   - Electrical Systems
   - Mathematics for Technicians II (Cont.)
   - Advanced Mechanics

5 – **Autonomous Navigation Challenge – Weeks 22-28**
   - Technical Drawing

6 – **Final Challenge, Robotics Competition – Weeks 29-36**

AIM begins with a short Bridge Builder activity , giving your class situation time to settle before robotics activities begin. The Bridge Builder activity teaches important math concepts and uses an experiential learning approach that prepare students for more complex AIM challenges.



$a^2 + b^2 = c^2$

Embedded Assessment

It's A Challenge

AIM is a math class taught in the context of engineering principles. For example, students learn about:

- Principles of pneumatic pressure and flow
- Materials Engineering
- Process Control Systems
- Basic hydraulic concepts
- Design of structures
- Surveying applications
- Electrical measurements
- Design processes
- Mechanical drives
- Manufacturing processes
- Plastics technology
- Quality assurance
- Thermal Systems
- Robotics and computer programming

Students pick up advanced engineering principles while they learn the math used in industry.

When students "take AIM" they can see their progress. Their comprehension is assessed throughout the course.

Quizzes

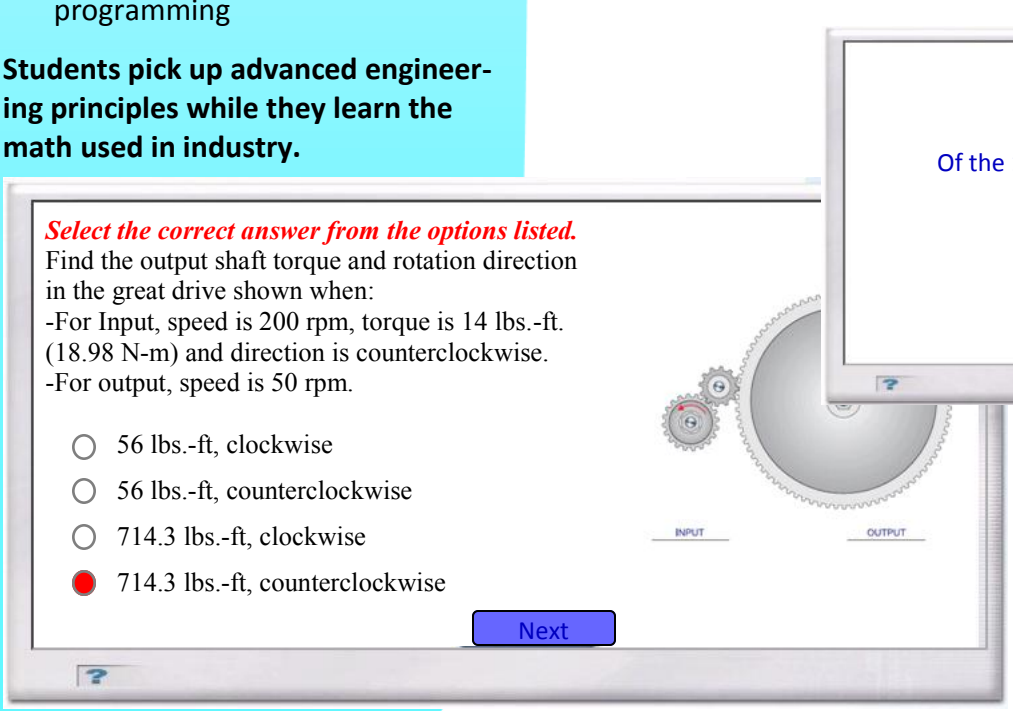
Quizzes embedded in the on-line learning system help ensure that students grasp the concepts presented. In addition to frequent quizzes, a graded Review is included at the end of each lesson.

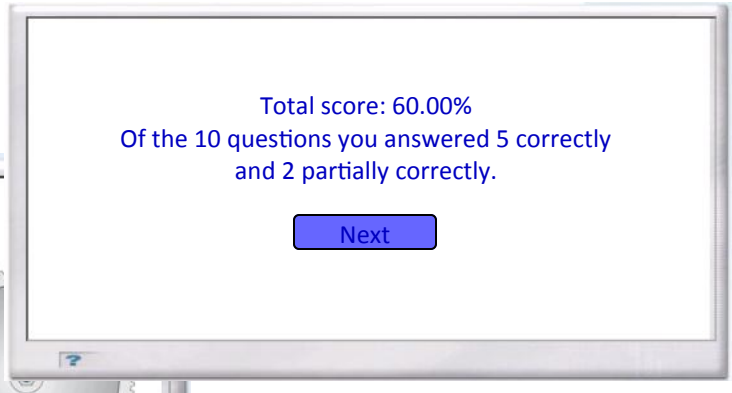
Worksheets

Students are given assignments in the form of worksheets that are downloaded, completed and submitted electronically to teachers.

Easy Grading and Assignment Workflow

It would be difficult for teachers to manually develop and grade dozens of quizzes and tests throughout the school year. The on-line learning system makes assessment automatic and allows students to look up results any time. Teachers won't spend hours grading tests!





ANALYTICAL INTEGRATED MATH

SCHOOL KIT

CLASSROOM KIT

TEAM KIT An open large blue tote pic-

ONE BOX FROM THE TEAM

Robot Kits

When a school launches AIM, it receives a shipment that includes the various items required for successful completion of the robot challenges students encounter throughout the course. These items are organized into three sub-kits:

- School Kit
- Classroom Kit
- Team Kit

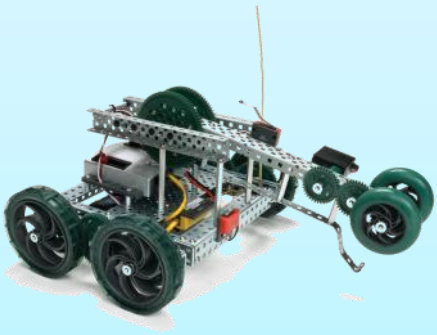
The **School Kit** contains items that make up one competition field and items needed for the challenges.

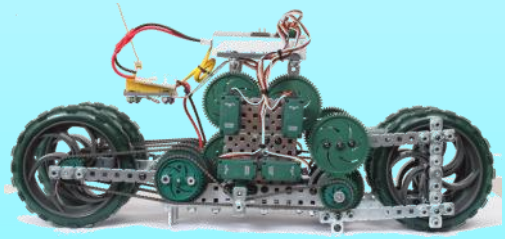
The **Classroom Kit** contains items necessary for general use by an entire class and commonly requested spare parts.

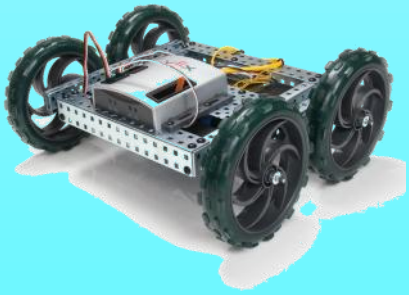
The **Team Kit** contains the parts needed to build a robot as well as the anticipated quantity of consumables used in a school year. Five sub-kits comprise the Team Kit—*System Starter*, *Power*, *Metal Hardware*, *Pneumatic* and *Drive Motor*. One Team Kit is required for every three students. The Team Kit is specifically designed to work in the "space and pace" of a high school classroom. Parts are organized and easily accessible. The Team Kit is easily retrieved, parts accessed, and the kit returned to a designated storage area at the end of each class. The Team Kit design saves teacher enormous time in school year preparation, and keeps students focused on learning, not finding parts.

At the end of the school year, robots are disassembled and parts are placed back into their respective locations. The teacher then can inventory the kits and order required replacement parts. Only a minimal number of consumable parts should need replacement. Team Kits are designed to last at least three years in high school classrooms.

Robots from VEX

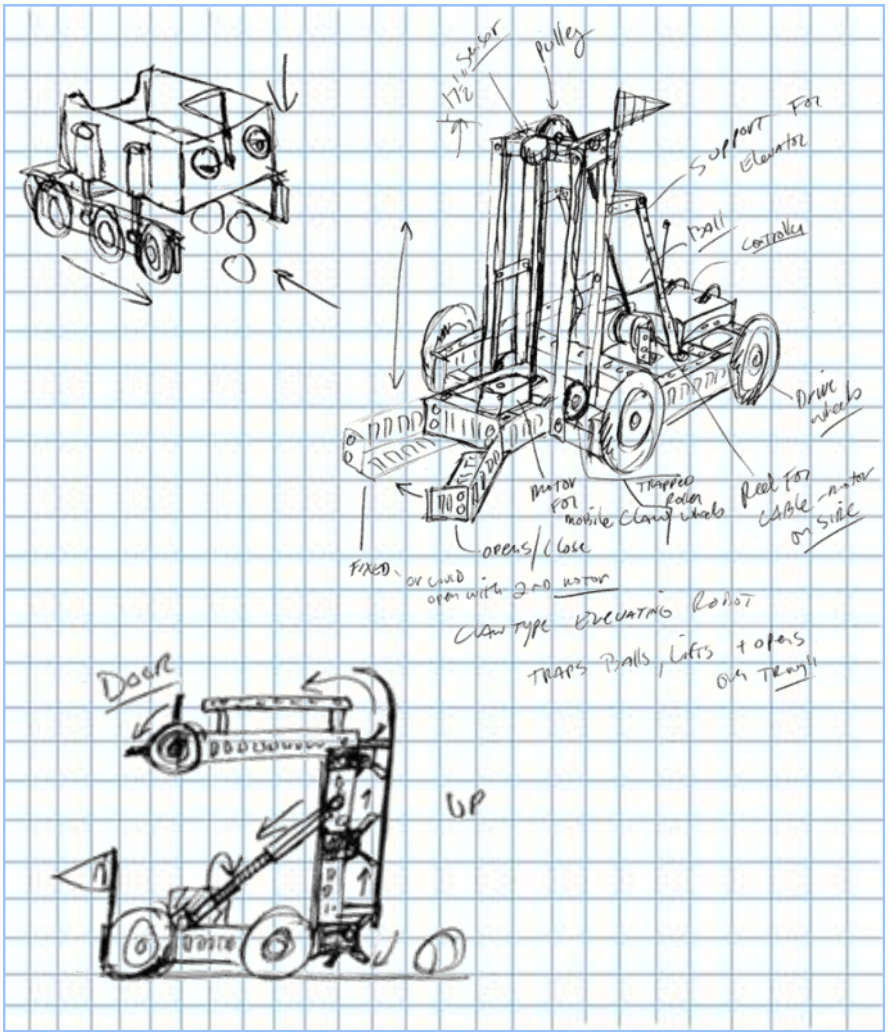






The robots supplied with AIM are from VEX Robotics, Inc., a subsidiary of Innovation First International, Inc. The VEX Robotics Design System offer students an exciting platform for learning about areas rich with career opportunities spanning science, technology, engineering and math (STEM). VEX Robotics encourages teamwork, leadership, and problem solving among groups.

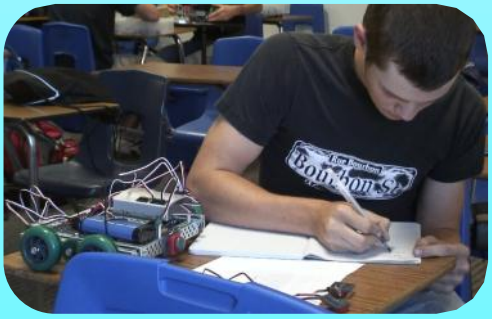
In any given class, no two robots will be designed and built alike! But all of the robots will perform the tasks assigned. This is a tremendous lesson for many students who have been educated in a traditional lecture setting. Students gain confidence in their own mathematical problem-solving abilities as they see their work come to life on the competition field.



ANALYTICAL INTEGRATED MATH

Ronald Tipton, A.J. Moore Academy, Instructor and member of the AIM design team

"Our brain is a pattern recognition computer. We took math patterns and we are fitting them into the pattern called robotics."

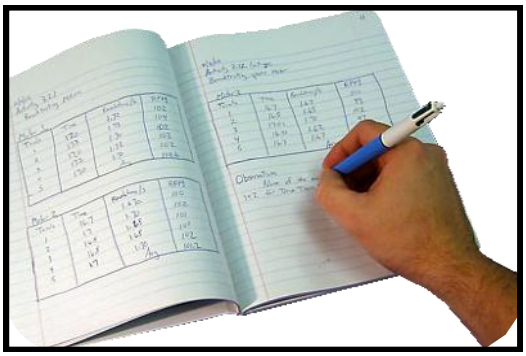


How Do Robots Teach Math?

The designers of AIM evaluated several different approaches and methodologies to achieve their goal. They wanted a math course that would give high school seniors the skills needed to pass the math portion of the college placement exams.

After many meetings, off-line conversations and interviews, they decided to teach math using robotics. Robotics is a practical application of the mathematics of physical engineering, allowing students to see the context of the detailed math formulas.

Contributing to their decision was their belief that if students could experience "hands on math," they would be able to grasp theory more rapidly and more completely, with higher rates of retention.

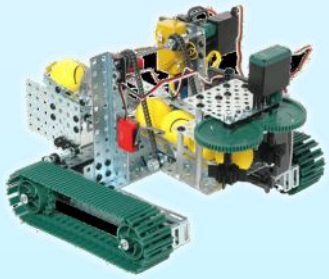


Obviously robots don't teach math. But students do learn math from working with robots to complete the unit challenges. For example, in Unit 2, in the lesson titled *Physics of Mechanisms*, students learn the mathematic principles behind Force, Work and Energy.

In a lesson title *Gear Ratio*, students use formulas to determine the number of teeth required in an input gear and output gear to produce a 4:1 ratio.

In the Unit Challenge they will be asked to construct and program a robot to scoop up and lift a tennis ball and then dispose of it, dropping it into a cylinder. In order to accomplish this task, the team will need to design the robotic arm to be able to lift the weight of the object. They must prove whatever concept they devise with the supporting documentation found in their Engineering Notebooks.

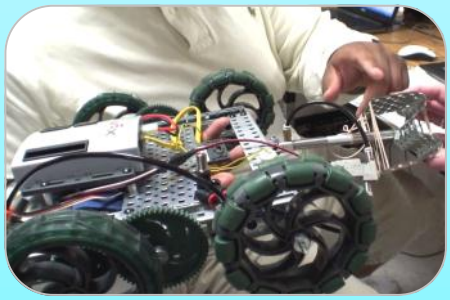
Take Me To Your Leader
12th Grade Math Students



End-of-Year Competition

The "final exam" for AIM students is the End-of-Year Competition. It is the last challenge in the AIM curriculum.

The work leading up to the final judging takes place over a period of eight weeks.



Success through Teamwork

Teamwork is a key factor on the competition field. Everyone must pull their weight in order to succeed.

End-of-Year Competition

Challenge

Students must design and build a motor-powered robot that navigates through a maze autonomously. The robot then completes a set of tasks by remote or autonomous control.

Preparation

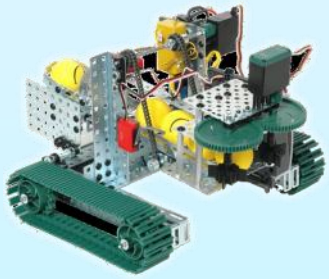
Students devise a plan to meet the design challenge. They document everything they do in their Engineering Notebooks. They repeat the cycle of building and testing their robots, and revise their plans through iteration.

Competition Day

Teams are judged on the thoroughness of their Engineering Notebooks. The notebooks reflect the application of the math concepts and team skills that students have developed while experiencing AIM. The notebook shows that students can apply math concepts to real world problems.

Teamwork, collaboration and friendly competition are evident as teams navigate through the maze and try to help one another overcome unforeseen hurdles and design obstacles.

Take Me To Your Leader
12th Grade Math Students



Experiential Learning

"Experiential Learning Theory (ELT) provides a holistic model of the learning process and a multi-linear model of adult development, both of which are consistent with what we know about how people learn, grow, and develop."

Experiential Learning Theory: Previous Research and New Directions. Kolb, 1999

Further, according to Kolb,

"knowledge results from the combination of grasping and transforming experience."

The Experiential Learning Cycle, depicted in Fig. 1, gives rise to the difference between so-called right-brained and left-brained learning.

An individual will either grasp an experience in a concrete manner or an abstract manner. And they will transform that experience actively or reflectively.

The developers of AIM were able to satisfy all conditions under which learning typically occurs in various students with their approach.

Professional Development

Pedagogy

The word pedagogy literally means "to lead the child." The pedagogy appropriate for teaching AIM is Experiential Learning. Much of the research supporting experiential learning is derived from *Constructivism*, a theory of learning developed by Jean Piaget, a Swiss psychologist. Piaget proffered that people construct knowledge through their experiences.

Teacher Training

In order to teach AIM, teachers must attend the AIM Summer Training Institute. This week-long course is taught by the AIM designers from the Waco ISD. As a prerequisite, teachers must have either a math or CTE certificate with a technology specialization. At the Summer Training Institute, participants will be taken through the entire AIM curriculum, experiencing learning as originally envisioned by the AIM design team.

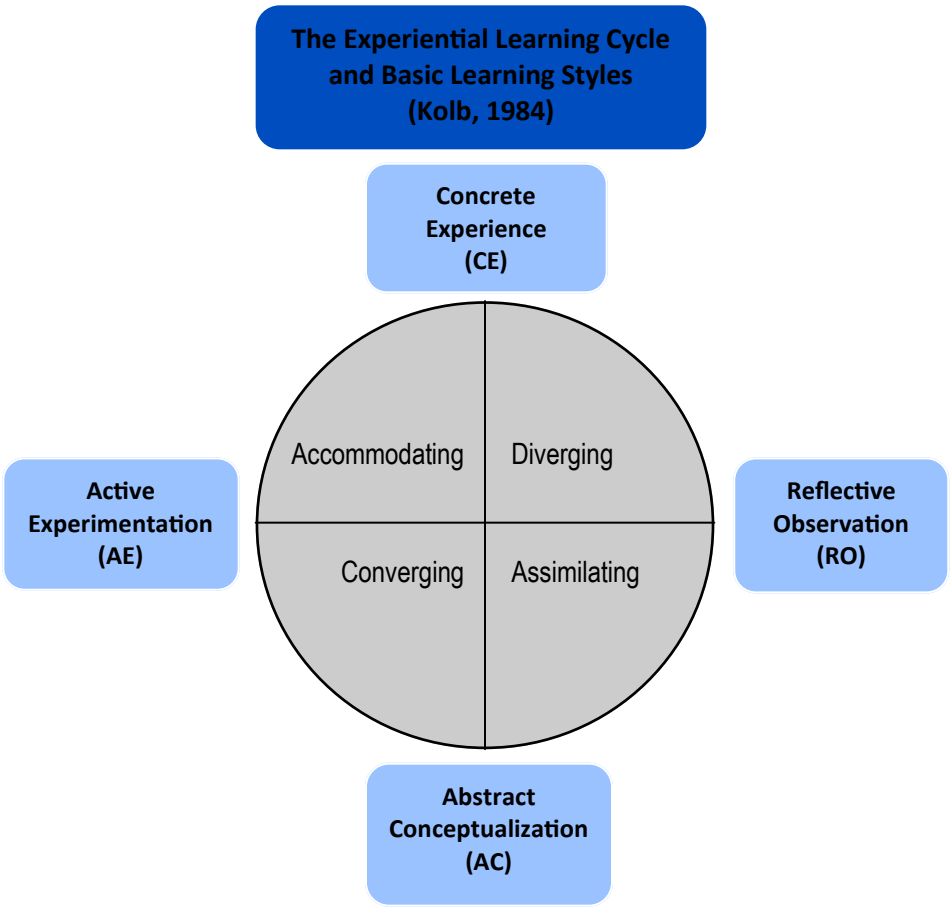


Fig. 1—Experiential Learning Cycle

ANALYTICAL INTEGRATED MATH

Computer Requirements

End User Computers

One computer is required for each student in the classroom

Minimum PC Hardware Requirements:

Pentium III, 256MB RAM, 2GB hard disk
Operating System: Windows 98, 2000 or XP, Vista, or Windows 7

Software:

Internet Explorer ver.6.0 or higher, Java-enabled, Macromedia Flash Player version 6.0 and higher
USB port for programming Vex robots

Server

One PC-based server is required per school.

Hardware Requirements:

P4, 3GHz, 2G RAM, at least 40GB Hard Drive

Operating System:

Windows 7, Windows Vista, Windows 2003 server, Windows 2000 server or Windows XP Pro

- Backup device
- UPS

Recommended:

High-speed internet connection for remote maintenance

Remote Connection Software for remote maintenance:

Remote Desktop or Virtual Network Connection (VNC)

Annual AIM Training and Delivery Schedule

Training

When a school signs up for AIM, their teachers are enrolled in the *AIM Summer Training Institute*. Updated training dates and locations are found on the web site at www.texasaim.com.

Delivery and Installation

The following timeline estimates when a school will receive their AIM kits and when installation of the server and desktop software will be complete. The timing is based on receipt of a purchase order.

Receipt of Purchase Order:
Delivery of Order and Installation Complete By

Before May 1	June 15
Before June 1	July 15
Before July 1	August 15
After July 1	As quickly as possible

Installation will be scheduled in coordination with the school's staff. Installation typically requires 2-3 days, and during that time, installers require access to the room/s where the AIM program will be delivered. The presence of the school's IT staff will be briefly required at the start of the installation, and their availability by phone will be required throughout the installation.

ANALYTICAL INTEGRATED MATH

About the AIM Partners

Program Founder and K-12 Partner

Waco Independent School District

Waco ISD is a co-founder of the AIM program and an ongoing advisor to the AIM Partnership, as well as a user of the AIM program. In 2007, Waco ISD led the team developing AIM. Waco ISD taught AIM in all three of the district's high schools. Today, like all AIM schools, AIM is now taught in Waco ISD for high school senior math credit.

Postsecondary Partner

Texas State Technical College

TSTC is the only state-supported technical college system in Texas. TSTC's statewide role and mission is to efficiently and effectively help Texas meet the high-tech challenges of today's global economy, in partnership with business and industry, government agencies, and other educational institutions. TSTC has high graduation rates, exceptional postgraduate success rates, and an outstanding record in graduating individuals from diverse cultural and socioeconomic backgrounds. Nearly 30,000 students are served each year through traditional degree programs, short-term continuing education and corporate training programs.

First Point of Contact, Robot Kits, Installation, Training and Support

DaVinci Minds

DaVinci Minds' mission is to build Capacity for Innovation in people, regions and organizations. Working at the intersection of technology, education and workforce development, DaVinci Minds offers products and services for middle schools, high schools, community colleges and universities. This includes integrated career, math and science curriculum, professional development and workshops, technology R&D and assessment services, and regional innovation services that span K-12, college, government and industry.

About the AIM Partners

Curriculum & Online Learning System Sales, Installation and Training

TSI

Online Learning System and Curriculum

intelitek

Robots Provided By

VEX ROBOTICS DESIGN SYSTEM

Teaching Systems Inc.

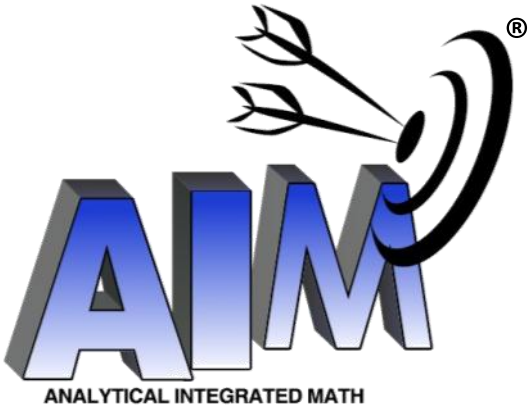
For over 45 years, Teaching Systems, Inc. has been in the business of selling high end, name brand, technical equipment, systems, software, services, curriculum support and turnkey laboratory solutions to educational institutions in the states of Texas, Oklahoma and New Mexico. These educational institutions range from early levels of public and private schools through graduate schools and associated research institutes. They include institutions with needs for laboratory support for Foreign Languages, ASL, Science, Technology, Engineering and Mathematics (STEM).

Intelitek

Intelitek is a USA based, world-leading developer, producer and supplier of comprehensive Hybrid (Blended) Learning solutions for training in Engineering, Automated Production, Mechatronics, Industrial Maintenance and Manufacturing Technologies. The company's broad product line includes CAD, CAM, CNC, Robotics, Machine Vision, Hydraulics and Pneumatics, PLCs, Sensors, Process Control and Data Acquisition. Intelitek also designs and produces Automated Manufacturing work cells for training, ranging from small-scale Flexible Manufacturing Systems (FMS) to complete Computer Integrated Manufacturing (CIM) systems.

Vex Robotics

The VEX Robotics Design System offers students an exciting platform for learning about areas rich with career opportunities spanning science, technology, engineering and math (STEM). These are just a few of the many fields students can explore by creating with VEX Robotics technology. Beyond science and engineering principles, a VEX Robotics project encourages teamwork, leadership and problem solving among groups. It also allows educators to easily customize projects to meet the level of students' abilities. The affordable VEX platform is expanding rapidly and is now found in middle schools, high schools and university labs around the globe. Robotics hobbyists also appreciate the advanced capabilities of the VEX System.



Thank you for your interest!

For more information about
Analytical Integrated Math,
you can find us at:

www.texasaim.com
210-399-1314
info@texasaim.com