Acellus

The Science of Learning

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Acellus Labs

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The Challenge

It is by now not only a well-known fact, but a thorn in our Nation's side that the children of America, as a whole, are falling short academically. The super awareness of our plight began in September of 2000 with the definitive study by John Glenn and his committee which generated the report -- "Before It's Too Late." From this we learned that out of 41 nations tested by the Third International Mathematics and Science Study, children in the United States, by the time of their high school graduation, "were almost last"*.

More recent reports are of schools that have adopted Zero Tolerance anti-drug programs and are expelling large numbers of students from school, permanently, after a single drug infraction -- leaving them no recourse, nowhere to go.

Other reports show the high school dropout rate steadily increasing as student absenteeism quickly puts kids so far behind that they lose hope of ever catching up. In too many cases, the street becomes their tutor, drugs and crime their future.

These students who started out just failing at math, soon find themselves failing at life.

As a result of these studies, there has been a tremendous National effort made to stem this tide of educational failure -- but with limited results. Recently *Reuters* reported, "The National Research Council found that U.S. students continue to perform among the worst of all industrialized countries because schools have a critical shortage of qualified teachers in science, math and technology."**

It's not that we don't know the goal. According to a recent interview of U.S. Secretary of Education Rod Paige, "The goal is to have an educational system in America that leaves no child behind, that educates 100 percent of our children."***

We even have a *general* idea of the means. "In order to do that," Paige went on to say, "a necessary condition is the effective use of technology."

Technology -- A Key

However, therein lies the challenge. As John Bailey, Director of Education Technology for the U.S. Department of Education put it, "It's not enough to install computers and wire schools and classrooms for Internet access. Today, the focus needs to expand to how schools are using technology." Bailey went on to emphasize the need for educators to consider *new* models of teaching that capitalize on technology's ability to personalize and customize learning.****

Many new programs have been developed, and a number have been implemented. Yet the problem remains and is getting worse.

A recent report funded by the U.S. Department of Education and conducted by the Education Commission of the States (ECS) studied how the U.S. is doing at complying with the new "No Child Left Behind" requirements. The report indicated that, although some progress had been made, only 12 states were on track in compliance with even half of the major federal requirements.

In addition, only eight states were close to having the required "highly qualified teachers" and aides in every classroom, a criteria that all teachers in all schools must meet by the year 2006.

Although the new law requires that all teachers be trained in the subjects they teach, research indicates that about one quarter of the high school and middle school core classes are taught by teachers not trained in those subjects. *****

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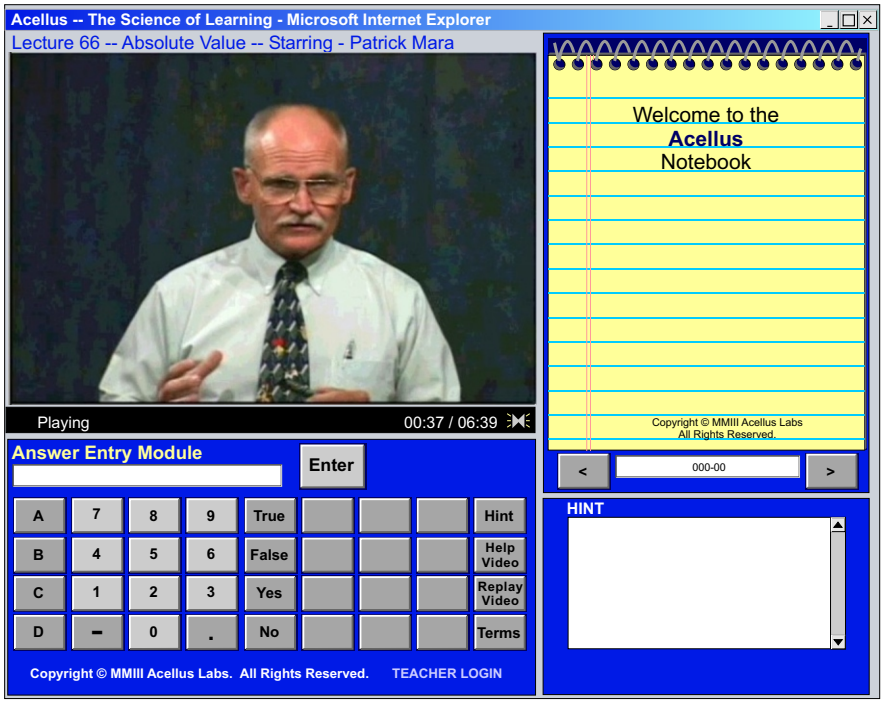
* "Before It's Too Late", The National Commission on Mathematics and Science Teaching, Sept., 2000, p.4.
** "Wanted, Math and Science Teachers", Reuters, July 31, 2002.
*** "Interview with Rod Paige", U.S. Secretary of Education, by Carol Patton, *School Executive Magazine*, Sep/Oct 2002, p.24.
**** "The Virtual Classroom", by Michele Sokoloff, *Media & Methods Magazine*, Sep/Oct 2002, p4.
***** "States strain to keep up with 'No Child Left Behind', by Greg Toppo, USA Today, January 29, 2003.

Introduction to Acellus

A new program that is specifically designed to address the education crisis in America is Acellus. Acellus is a computerized, video-based, interactive education tool that integrates time-proven methods of teaching with the latest advancements in technology, delivering a complete and effective learning experience. Acellus has recently been used to develop courses in mathematics and science aimed at helping to meet the educational challenges facing this Nation.

The innovative technology of Acellus makes it interactive, so the program tailors itself to the pace and level of each individual student. Acellus moves through mathematics concepts quickly, assessing students' understanding of those concepts and then adjusting to provide more basic explanations when it encounters an area where they have difficulty.

Acellus has been specifically designed to eliminate holes in students' understanding -- a primary source of failure in mathematics. Through the power of the Acellus education tool, students who are struggling at the bottom of their class -- or who have dropped out of school entirely -- are finding new hope for a better future, as they progress at their own pace through an interactive program that builds concept by concept, filling the voids in their knowledge, giving them new abilities and greater self-esteem.



The Student Interface Console:
The Acellus Student Interface Console for FUNdamental Mathematics consists of the *Lecture/Problems* window, where students watch video lessons and then see problems on the lecture material; the *Notebook* window, where notes are automatically taken during each lecture; the *Answer Entry Module*, where students enter their answers to the problems; and the *Hint* window, where students can receive a "hint" on a problem they are struggling with.

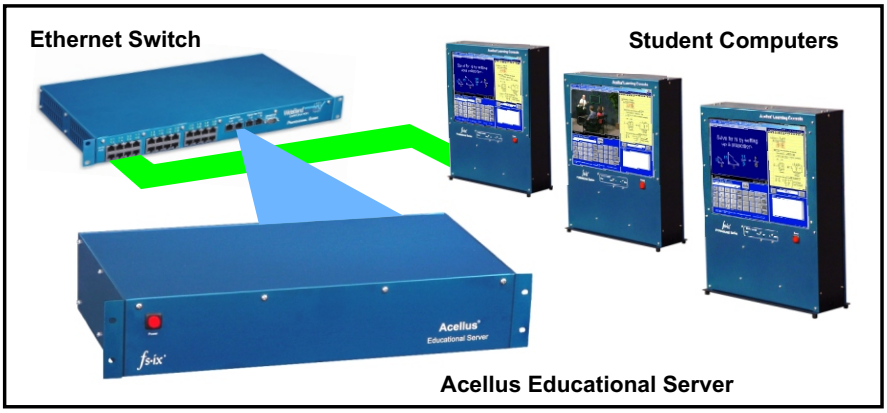
The Acellus Education Tool

The interactive Acellus education tool has been created to accomplish the following purposes:

1. To present lectures to students
2. To monitor student progress and identify specific areas of difficulty
3. To provide an alternative learning path for a course, dependent upon the specific difficulties experienced by each student
4. To assess the overall effectiveness of the teaching process as currently implemented on Acellus and determine areas of deficiency that require modification

> *The basic premise of Acellus is that even the best teaching by our finest teachers could be improved and made more effective if the learning process itself could be made into a science and studied in analytical terms.*

It is possible to install any course or curriculum into the Acellus learning environment. By choosing competent and experienced teachers to present the initial



Acellus Learning Lab
The Acellus Learning Laboratory consists of the Acellus Server, networking equipment, and consoles for up to 25 students. The Acellus Server contains all of the course information and collects data regarding the learning process which is communicated each night to the Master Server.

lectures in Acellus, those who are developing courses for Acellus can start out with "state-of-the-art" quality in course materials. Then, as students begin to progress through the course, Acellus accumulates an exhaustive database which quickly identifies areas of deficiency in the learning process.

Extensive Database

The teaching procedure is simple, yet effective. First, the student is presented a lecture. This is accomplished through high-quality video with sound, giving the student a similar feeling of interaction as if in a conventional classroom.

After the lecture, the student is challenged by being asked to work several problems. The problems test the student's comprehension of the material that was presented. The answers provided to Acellus by the student enable the system to determine whether or not the student comprehends the material. If a student gets the required number of consecutive problems correct (the default number is three in a row), the course moves forward and the next lecture video is presented.

On the other hand, if the student misses some problems or requests a hint to help solve a problem, it is then determined that the student did not adequately master the material. At this point, Acellus presents a more in-depth lecture, which covers much of the same material as the lecture just completed, but which explains concepts at a more basic and fundamental level. Acellus has the ability to support dozens of levels of instructional videos on each topic of the course, all of which are delivered to specific students based on their success in solving problems or based on their own decision to see a more in-depth explanation of the topic.

In this way, the student progresses through the course by alternately watching lectures presented in video format and then working problems to master and demonstrate competence in a particular subject matter.

At appropriate points throughout the course, Acellus presents the students with examinations. The tests review concepts taken from completed lectures and assess student competence with the material. These assessments can be used as one of the bases for grading student progress.

Daily Updates

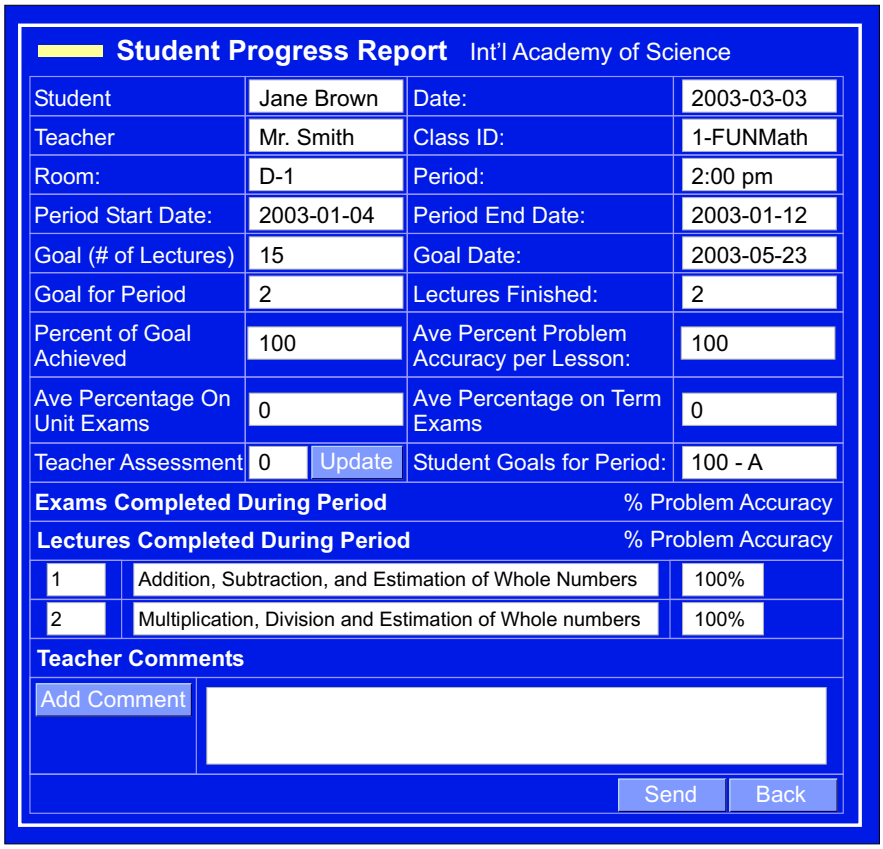
All of this is, however, only the beginning of the potential of Acellus. Acellus Servers installed in schools throughout the entire country and even internationally, interact daily with the Master Server located at the International Academy of Science in Independence, Missouri. During these daily interactions, the Acellus Servers report information regarding the learning process of students enrolled at their respective schools. The Master Server then delivers to the Acellus Servers the updates and enhancements to the course materials that were made that day.

After even a short period of time, a considerable database of information concerning the learning process is assembled on the Master Server where it is automatically organized for analysis and assessment.

It is this substantial database of specifically relevant information that provides the unique Acellus feature of turning the learning process into a science.

Consider as an example one of the lectures in a FUNdamental Mathematics course that has been developed for the Acellus environment. During the initial lecture (the "A" Lecture), the teacher presents the material to the students, using conventional teaching techniques similar to those used in classrooms throughout the country. After each lecture, the course pauses and the students are asked to demonstrate their understanding of the lecture by working problems.

In a perfect world, every student would get every problem correct. However, in the real world of mathematics education, that is rarely the case. It is true that after certain lectures a vast majority of the students do successfully complete all of the problems without errors. It can be assumed, then, that these lectures were successful in conveying the specific concepts of the material to all of the students.



The Student Progress Report:
The Acellus Administrator Interface provides teachers with a sophisticated capability of supervising the learning process, providing many interface screens which allow them to observe and guide individual students and the class as a whole. This interface allows teachers to, among other things, monitor the progress of students in the course, assign grades, and administer other functions as may be required.

The Power of Feedback

The Acellus learning system compiles statistical reports of student responses to each of the problems. Immediately upon evaluation of this data, some problems begin to stand out, due to the large number of students that are not able to answer them correctly. Researchers analyze this Acellus feedback, first by looking at the problems themselves. Is the problem confusing or ambiguous? To assist them in this undertaking, Acellus captures all of the wrong answers of all of the students who answered that problem worldwide. By looking at the incorrect answers, it is possible to determine if the problem is being misunderstood by the students, or if an alternative correct answer has been overlooked by the system programmers. If either of these is the case, the solution is straight-forward: either the problem is modified to remedy the ambiguity, or alternative correct answers are added to the database. The very next day, all of the students throughout the entire worldwide system will see the newly refined version of the problem, since all programming changes and updates are distributed to the entire system on a daily basis.

Sometimes the difficulty is not a result of the math problem but is, in fact, an indication of the students' inability to understand the concept being taught. Acellus researchers refer to these concepts as "stubborn concepts" or concepts that a significant percentage of students have difficulty learning or understanding.

Once a stubborn concept has been identified by analyzing the Acellus database of student records, it is necessary to devise a scheme or

method to help students master the concept. In many cases, the solution is an alternative approach in teaching the lesson. After carefully analyzing the "wrong answers" of the students in the database, the teachers are able to re-teach the lecture using alternative examples or teaching approaches in an effort to better accomplish the teaching goal. Since the new lecture is propagated throughout the entire system overnight, the next day Acellus begins to collect new statistical data showing the effectiveness (or ineffectiveness) of the new teaching method as compared to the method of the earlier lecture.

By going through a process of continual iterations of the lesson material, Acellus has significantly improved students' understanding of mathematic concepts -- especially "stubborn concepts".

Another technique that has been discovered to help students with stubborn concepts is being used when a substantial number of students answer a problem with the same incorrect answer. One such example in the Acellus FUNdamental Mathematics program occurred with the problem $5^2 + 3x8 = ?$. Although the answer is *49*, a statistically significant number of students entered *34* as their answer. This occurrence was documented by the Acellus database tools and discovered by the mathematics teaching analysis team during their review. The team immediately discerned that the reason students were entering the incorrect answer of *34* was because they were forgetting that a number squared is the number times itself, not the number times two ($5^2 = 5x5 = 25$ not $5x2 = 10$).

In Acellus, this circumstance is referred to as a "special" problem or a problem to which a statistically significant number of respondents all get the same wrong answer. Once a special problem has been identified, it is then possible for the instructor to label the problem "special" and to create a "special" lecture response for any student in the future that enters this specific wrong answer. In the case above, a custom video clip was added so that the next time a student inaccurately entered the answer of *34* instead of *49* to this problem, the teacher reappeared in a video on the student's screen saying, "Now, you said that the answer to this question is '34', and I know the mistake you made. . . . " The teacher went on to show the student the mistake and how to fix it. By providing specific instruction to help a student with a specific concept, Acellus makes the learning process truly interactive -- almost like having a teacher one-on-one with each student.

From the database that has been generated from the use of Acellus to teach FUNdamental Mathematics, it has been learned that in the entire course there are only a few dozen of these special problems, especially after the lectures have been optimized based on student feedback. In every case, a customized response has been prepared.

Curriculums and Courses

The International Academy of Science has launched the use of the Acellus learning environment with two courses, "FUNdamental Mathematics" and "Algebra I".

The curriculums for these courses integrate the standards set forth in the National Council of Teachers of Mathematics' Principles and Standards for School Mathematics.

A listing of the lectures in the FUNdamental Mathematics and Algebra I courses is presented in Appendices 1 and 2. The Academy is currently developing other courses for use in the Acellus learning environment, including AP Calculus and Algebra II.

The Acellus interface has been developed to be user friendly, so that educators without a programming background can install any curriculum they wish on Acellus without spending time writing and debugging programs. The International Academy of Science offers a special course for educators desiring to place other curriculums into the Acellus learning environment. The interface runs in standard browsers, making it possible to use the tool with virtually any brand of computers including IBM PC's and Apple.

Acellus Applications

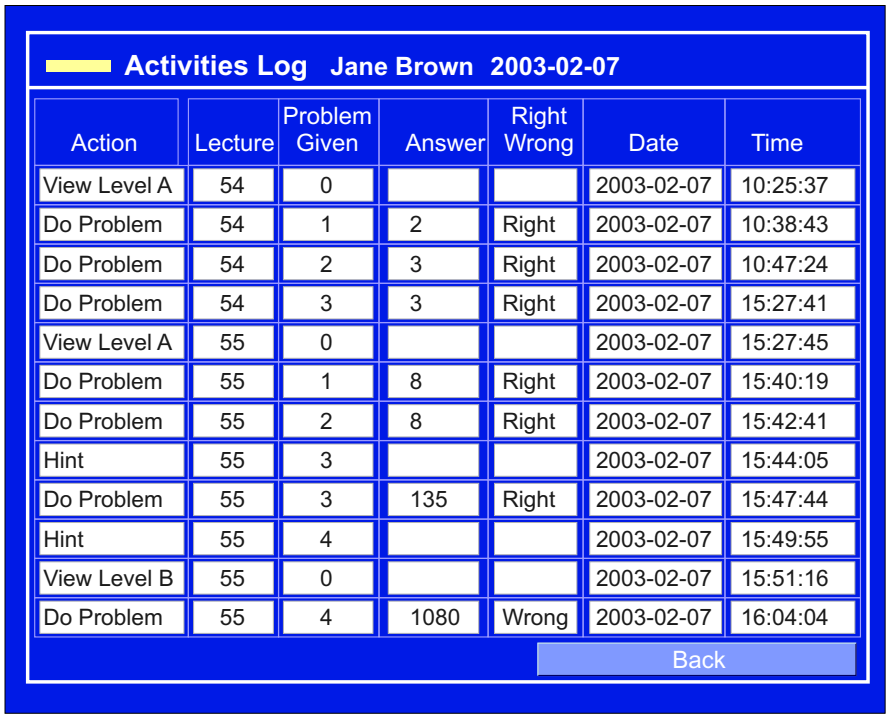
FUNdamental Mathematics, developed by the International Academy of Science in conjunction with Acellus Labs, was specifically designed for students of high school and college age that desire to go on to college but have not acquired the basic skills in fundamental mathematics to be able to pursue a college program.

In practice, Acellus FUNdamental Mathematics is being used in a variety of applications such as in middle schools and high schools, where it is being utilized as a mainstream teaching method for students; in alternative schools, where students who are on very different levels receive the personalized instruction they need; in adult or evening schools, where students are trying to earn a high school diploma; and in detention facilities where students who have been imprisoned are improving their skills in preparation for a future after they are released.

An online version of Acellus FUNdamental Mathematics is also now available, which allows students to access the program over the Internet. This version of the program is tailored for students who are not doing well in school and wish to do a little “brushing up” in the evenings or during the summer months at home, and by students who are being home schooled by their parents.

Other applications for Acellus are in rural communities where only a small percentage of the student body has the aptitude and the interest in taking courses like Physics and Calculus. Acellus can be administered in these environments by other teachers, giving students in small rural schools the same pre-college preparation as students in the largest and finest of our nation's high schools.

Since Acellus collects demographic information on all students and correlates this with their performance, it will be possible to develop specialized versions of instruction which more perfectly cater to the individual needs of different demographic classes of students. For example, Hispanic students struggling to learn English as a second language will benefit considerably if they are able to enroll for a class in Algebra I taught by a Spanish-speaking instructor. Not only could the instructor explain the concepts of Algebra to them in a language they understand, but the teacher could also teach them the Algebra terminology in English so that when they go on to Algebra II, they will be able to succeed in a classroom of their peers which is taught in English.



Activities Log Jane Brown 2003-02-07

Action	Lecture	Problem Given	Answer	Right Wrong	Date	Time
View Level A	54	0			2003-02-07	10:25:37
Do Problem	54	1	2	Right	2003-02-07	10:38:43
Do Problem	54	2	3	Right	2003-02-07	10:47:24
Do Problem	54	3	3	Right	2003-02-07	15:27:41
View Level A	55	0			2003-02-07	15:27:45
Do Problem	55	1	8	Right	2003-02-07	15:40:19
Do Problem	55	2	8	Right	2003-02-07	15:42:41
Hint	55	3			2003-02-07	15:44:05
Do Problem	55	3	135	Right	2003-02-07	15:47:44
Hint	55	4			2003-02-07	15:49:55
View Level B	55	0			2003-02-07	15:51:16
Do Problem	55	4	1080	Wrong	2003-02-07	16:04:04

Back

Student Activities Log Report
In this screen, the teacher monitors which lecture the student is on, the number of problems the student has answered, the correct or incorrect answers that were given (and specifically what those answers were), and the amount of time the student spent working on each problem. The teacher can also see when a student requested a hint or watched a Level B lecture. The student data from this report can help a teacher zero in on specific problems and concepts a student may be struggling with.

Conclusion

Acellus has opened a new opportunity in science and mathematics education. The technology has already achieved a significant level of success, and this is only the beginning.

To take full advantage of the power and sophistication of the Acellus education tool, the following projects should be undertaken:

1. Various teams should be assembled to develop courseware for Acellus. Based on interest from schools throughout the country, the subjects of Algebra II, Geometry, Trigonometry, Biology, Chemistry, and Physics should be given top priority.
2. Scientific assessment of the effectiveness of Acellus should be performed, both to optimize the quality of the courses and to determine the overall effectiveness of the tool.
3. Development projects need to be launched to make Acellus Laboratories available to "needy" schools on a top priority basis.
4. The developers of the Acellus tools need to refine and enhance Acellus to facilitate the teaching of reading and other subjects that are beyond the scope of the original development project.

About the Author

Dr. Roger E. Billings
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Acellus creator Dr. Roger E. Billings -- the same innovator noted for his pioneering work in developing the personal computer, computer networking, and hydrogen energy -- has turned his technical and creative focus to the great educational need of the children of America.

Drawing from his career-long commitment to effective education and his extensive background in the computer field, he and his team have spent the past five years developing the complex Acellus learning system -- a system that is not only teaching math, but is also changing lives.

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Appendix I

INTERNATIONAL ACADEMY OF SCIENCE
FUNdamental Mathematics Course Curriculum

Lecture	Description
"0"	Introduction & Overview: Building Blocks of Mathematics
1	Adding, Subtracting, and Estimating Whole Numbers
2	Multiplying, Dividing, and Estimating Whole Numbers
3	Divisibility
4	Prime and Composite Numbers
5	Greatest Common Factor (GCF)
6	Prime Factorization
7	Place Value
8	Estimating
9	Order of Operations
10	Powers of 10 and Estimation
11	Formulas and Variables
12	Ratios, Rates, and Proportions
13	Forms of Fractions: Improper and Mixed Numbers
14	Simplifying Fractions: Reducing, Comparing, and Equivalents
15	Least Common Multiple (LCM)
16	Adding and Subtracting Simple Fractions
17	Adding and Subtracting Mixed Numbers
18	Multiplying and Dividing Simple Fractions
19	Multiplying and Dividing Mixed Numbers
20	Adding and Subtracting Decimals
21	Multiplying Decimals
22	Dividing Decimals
23	Comparing and Ordering Decimals
24	Dividing By Powers of 10
25	Terminating and Repeating Decimals
26	Standard and Scientific Notation
27	Metric System
28	Forms of Percent: Fractions, Decimals, and Percent
29	Percent: Missing Percent, "Is" and "Of"
30	Simple Interest
31	Applied Percent: Sales Tax, Discount, Percent of Inc. or Dec.
32	Circle Graphs
33	Counting Principle and Tree Diagrams
34	Basic Probability
35	Independent and Dependent Events
36	Prediction with Probability
37	Factorials
38	Permutations: Ordered Subsets
39	Combinations: Unordered Subsets
40	Mean (Average), Median, Mode, and Range
41	Frequency Tables
42	Bar and Broken-Line Graphs
43	Other Graphs: Scatter, Stem-and-Leaf, and Box-and-Whisker Plots
44	Reading and Interpreting Graphs
45	Misleading Statistics
46	Planes, Points, and Lines
47	Symbolism and Vectors
48	Angles
49	Parallel Lines and Transversals
50	Sum of the Angles of a Triangle
51	Classifying Triangles
52	Congruent vs. Similar Triangles
53	Polygons: Triangles and Quadrilaterals
54	Other Polygons: Regular and Irregular
55	Angles in Regular Polygons
56	Length: Perimeter
57	Two-dimensional Shapes: Area
58	Three-dimensional Figures: Volume
59	Surface Area
60	Square Roots and the Pythagorean Theorem
61	Circles and Spheres
62	Transformations: Reflections, Translations, and Rotations
63	Symmetry
64	Set Notation and Venn Diagrams
65	Compare and Order Integers
66	Absolute Value
67	Adding Integers
68	Subtracting Integers
69	Multiplying and Dividing Integers
70	Order of Operations with Integers
71	Zero, Identity, Commutative, Associative, and Distributive
72	Basic Graphing: Ordered Pairs and the Coordinate Plane
73	Comparing and Ordering Rational Numbers
74	Adding and Subtracting Rational Numbers
75	Multiplying and Dividing Rational Numbers
76	Expressions vs. Equations
77	Order of Operations: With and Without Variables
78	Translating Algebraic Words to Symbols
79	One-Step Equations
80	Rational Numbers: Decimals and Fractions
81	Two-Step Equations
82	Formulas and Literal Equations
83	Patterns and Functions
84	Graphing Straight Lines with Slope as a Rate of Change
85	Basic Inequalities: One-Step and Two-Step Inequalities

Appendix II

INTERNATIONAL ACADEMY OF SCIENCE
Algebra I Course Curriculum

Lecture	Description
1	Expressions -- Verbal and Algebraic
2	Algebraic Patterns
3	Order of Operations
4	More Order of Operations
5	Open Sentences
6	Some Basic Properties of Algebra
7	Distributive Property
8	Integers and Sets of Numbers
9	Integer Arithmetic
10	Absolute Value
11	A Formal Definition of Addition
12	Compare and Order Rational Numbers
13	Add, Subtract, Multiply, and Divide Rational Numbers
14	Square Roots, Square Numbers, and Irrationals
15	One-Step Equations Using Addition and Subtraction
16	One-Step Equations Using Multiplication and Division
17	Properties of Equality
18	Two-Step Equations with Manipulatives
19	Complement and Supplement Problems
20	Clearing Fractions and Decimals
21	Number Problems
22	Consecutive Integers
23	Perimeter and Angle Problems
24	Multi-Step Equations
25	Literal Equations
26	Solve Proportions
27	Similar Triangles
28	Percent -- A Special Kind of Ratio
29	Simple Interest
30	Percent of Increase or Decrease
31	Probability and Odds
32	Mixtures
33	Uniform Motion
34	Ordered Pairs and Relations
35	Graphing Linear Equations
36	Writing Equations Given Relations
37	Definitions of Slope
38	Calculating Slope
39	Point-Slope Formula
40	Slope-Intercept Formula
41	Shortcuts to Graphing
42	Parallel & Perpendicular Slopes
43	Equations of Parallel & Perpendicular Lines
44	Midpoints
45	Graphing Absolute Value
46	Parabolas
47	Solving Equations with a Calculator
48	Solving Inequalities Using Addition and Subtraction
49	Solving Inequalities Using Multiplication and Division
50	Multi-Step Inequalities
51	Graphing Inequalities
52	Solving Systems of Equations by Graphing
53	Solving Systems by Substitution
54	Solving Systems by Addition
55	Solving Systems by Multiplication
56	Graphing Systems of Inequalities
57	Polynomial Terminology
58	Polynomials with Algebra Tiles
59	Adding Polynomials with Algebra Tiles
60	Subtracting Polynomials with Algebra Tiles
61	Multiplying and Dividing Monomials with Algebra Tiles
62	Multiplying Polynomials by Monomials
63	Multiplying Polynomials
64	Multiplying Binomials Using FOIL
65	Special Products
66	Factoring Out the GCF of a Polynomial
67	Binomial Factors
68	Factoring Using FOIL
69	Zero Product Property to Solve Equations
70	Simplifying Rational Expressions
71	Dividing a Polynomial by a Binomial
72	Multiplying Rational Expressions
73	Dividing Rational Expressions
74	Adding and Subtracting Rational Expressions
75	Simplifying Square Roots
76	Simplifying Radical Expressions
77	Rationalizing Denominators
78	Radical Expressions
79	Radical Equations
80	The Distance Formula
81	Quadratic Equations
82	Completing the Square
83	Quadratic Formula
84	Rules of Exponents

Appendix III

INTERNATIONAL ACADEMY OF SCIENCE
Geometry Course Curriculum

Lecture	Description	Lecture	Description	Lecture	Description
1	Introduction - Points, Segments, and Length	31	Exterior Angles	61	Areas of Similar Figures
2	Pythagorean Theorem and Distance Formula	32	Congruency of Triangles - Definition	62	Similarity - SSS and AAA
3	Rays, Angles, and Planes	33	SSS and SAS	63	Similarity - SAS
4	Measuring Angles and Perpendiculars	34	ASA and SAA	64	Trigonometric Ratios
5	Congruency - Size and Shape	35	HL Theorem	65	Applications of Trigonometry
6	Inductive Reasoning	36	Isosceles Triangle Theorem	66	Definitions - Radius, Diameter, and Chord
7	Deductive Reasoning	37	Perpendicular Bisector	67	Tangent Lines
8	If Then Statements and Truth Tables	38	Perpendicular Bisectors of a Triangle	68	Formula for the Circumference
9	Converse	39	Angle Bisectors	69	Formula for the Area of a Circle
10	Inverse	40	Altitudes	70	Arcs
11	Contrapositive	41	Medians	71	Arc Length
12	Postulates and Proofs	42	Area vs Perimeter	72	Area of a Sector
13	Introduction to Transformations	43	Polygons - Part A	73	Radius and Chord Properties
14	Reflections	44	Geometric Probability	74	Inscribed Angles
15	Rotations	45	Area Under a Curve	75	Secant and Tangent Line Properties
16	Translations	46	Pythagorean Theorem and Distance Formula	76	Surface Area of Prisms
17	Vectors	47	30-60-90 Triangles	77	Surface Area of Pyramids
18	Dilations	48	45-45-90 Triangles	78	Surface Area of Cylinders
19	Tessellations	49	Converse of Pythagorean Theorem	79	Surface Area of Cones
20	Symmetry	50	Quadrilaterals	80	Surface Area of Spheres
21	Angle Addition Postulate	51	Parallelograms	81	Volume of Prisms
22	Complement and Supplement	52	Rhombi	82	Volume of Pyramids
23	Vertical Angles	53	Rectangles and Squares	83	Volume of Cylinders
24	Angle Bisectors	54	Polygons - Part B	84	Volume of Cones
25	Transversals	55	Regular Polygons	85	Volume of Spheres
26	Alternate Interior and Corresponding Angles	56	Polyhedra	86	Ratios of Surface Area and Volumes
27	Corresponding Angle Postulate	57	Euler's Formula	87	Changing Units of Measure
28	Triangles Classified By Sides	58	Regular Polyhedra	88	Problem Solving
29	Triangles Classified By Angles	59	Definition of Similar	89	Problem Solving
30	180 Degree Theorem	60	Perimeters of Similar Figures	90	Problem Solving

Appendix IV

INTERNATIONAL ACADEMY OF SCIENCE
Algebra II Course Curriculum

Lecture	Description
0	Introduction to Algebra II
1	Real Numbers and Operations
2	Multiplication and Division of Real Numbers
3	Algebraic Expressions and Properties of Numbers
4	The Distributive Property
5	Solving Equations
6	Writing Equations
7	Exponential Notation
8	Properties of Exponents
9	Scientific Notation
10	Field Axioms, Theorems, and Proofs
11	More on Solving Equations
12	Using Equations
13	Solving Formulas
14	Solving Inequalities
15	Using Inequalities
16	Compound Inequalities
17	Absolute Value
18	Relations and Ordered Pairs
19	Graphs
20	Definition of a Function
21	Graphs of Linear Equations
22	Slope
23	More Equations of Lines
24	Parallel and Perpendicular Lines
25	The Absolute Value Function
26	Composition of Functions
27	Systems of Equations in Two Variables
28	Solving Systems of Equations
29	Using a System of Two Equations
30	Systems of Equations in Three Variables
31	Using a System of Three Equations
32	Consistent and Dependent Systems
33	Systems of Inequalities
34	Polynomials and Functions
35	Addition and Subtraction of Polynomials
36	Multiplication of Polynomials
37	Factoring
38	The Big X Method of Factoring
39	Solving Equations by Factoring
40	Multiplying and Simplifying Rational Expressions
41	Addition and Subtraction of Rational Equations
42	Complex Rational Expressions
43	Division of Polynomials
44	Synthetic Division
45	Solving Rational Equations
46	Formulas
47	Radical Expressions
48	Multiplying and Simplifying Radical Expressions
49	Operations with Radical Expressions
50	Rational Numbers as Exponents
51	Solving Radical Equations
52	Imaginary and Complex Numbers
53	Introduction to Quadratic Equations
54	Using Quadratic Equations
55	The Quadratic Formula
56	Solutions of Quadratic Equations
57	Equations Reducible to Quadratic Form
58	Formulas and Problem Solving
59	Symmetry
60	Transformations of Functions
61	Stretching, Shrinking, and Reflecting Functions
62	Graphs of Quadratic Functions
63	Standard Form for Quadratic Functions
64	Graphs and x-intercepts
65	Coordinate Geometry
66	Conic Sections: Circles
67	Ellipses - Part I
68	Ellipses - Part II
69	Hyperbolas
70	Parabolas
71	Second-Degree Equations and Systems
72	Polynomials and Polynomial Functions
73	The Remainder and Factor Theorems
74	Rational Roots
75	Theorems About Roots
76	Graphs of Polynomial Functions
77	Inverse Functions
78	Exponential and Logarithmic Functions
79	Exponential and Logarithmic Relationships
80	Properties of Logarithmic Functions
81	Logarithmic Function Values
82	Exponential and Logarithmic Equations
83	Natural Logarithms and the Number e

Appendix V

INTERNATIONAL ACADEMY OF SCIENCE
Trigonometry Course Curriculum

Lecture	Description	Lecture	Description
1	Similarity and Proportion	30	Graph of Cotangent
2	Right Triangles - 30-60-90	31	Amplitude
3	Right Triangles - 45-45-90	32	Period
4	Rationalizing the Denominator	33	Horizontal Translations
5	Degrees, Minutes, Seconds	34	Vertical Translations
6	Sine, Cosine, and Tangent	35	Reviewing Graphing Concepts
7	Word Problems with Sin, Cos, and Tan	36	Reviewing Identities
8	Pythagorean and Tangent Identities	37	Co-function Identities
9	Radians and Special Angles	38	Negative Angle Identities
10	Arc Length	39	Simplifying Expressions
11	Sector Area	40	Combining Like Terms
12	Extended Angles - Coterminal	41	Square Roots
13	Unit Circle	42	Factoring
14	New Definitions - Part I	43	Quadratics
15	New Definitions - Part II	44	Sum and Difference Formulas - Sine and Cosine
16	Reciprocal Functions	45	Sum and Difference Formulas - Tangent
17	Inverse Functions	46	Double-Angle
18	Areas of Triangles	47	Half-Angle
19	Law of Sines	48	Problem Solving - Part I
20	Law of Cosines	49	Problem Solving - Part II
21	Magnitude and Direction	50	Problem Solving - Part III
22	Horizontal & Vertical Components	51	Problem Solving - Part IV
23	Adding Vectors Geometrically		
24	Adding Vectors Algebraically		
25	Compass Headings		
26	Graph of Sine, Cosine, and Tangent		
27	Graph of Cosine		
28	Graph of Tangent		
29	Graphs of Secant and Cosecant		

Appendix VI

INTERNATIONAL ACADEMY OF SCIENCE
AP Calculus Course Curriculum

Lecture	Description
1	Parent Functions: $y = x^2$
2	Polynomial Functions: Power Functions: $y = ax^n$
3	Trigonometric Functions: y = sin(x), y = cos(x)
4	Other Trigonometric Functions
5	Radical Functions
6	Rational Functions
7	Inverse Functions
8	Logarithmic and Exponential Functions
9	Polynomial Inequalities
10	Introduction to Limits
11	Computation of Limits - Part I
12	Indeterminate Forms
13	Computation of Limits - Part II
14	Limits to Infinity
15	Proving Continuity
16	Intermediate Value Theorem
17	Types of Discontinuity
18	Average vs. Instantaneous Velocity
19	The Tangent of $y = x^2$
20	The Tangent of y = 1/x
21	The General Rule of the Derivative
22	Derivatives of Constant and Linear Functions
23	The Power Rule for Derivatives
24	Combination Rules: Sum and Difference
25	Combination Rule: Product Rule
26	Combination Rule: Quotient Rule
27	Tangent and Normal Lines
28	Approximating Values of Functions Using Local Linearization
29	Local Linearity and Differentiability
30	Derivative of Trigonometric Functions - Part I
31	Derivative of Trigonometric Functions - Part II
32	Product and Quotient Rules with Trigonometric/Algebraic Functions
33	Numerical Derivative with a Calculator
34	Predicting what f'(x) Looks Like Graphically
35	Introduction of the Graph of the Derivative - Calculator-Based
36	The Chain Rule
37	The Chain Rule Activity
38	Velocity of a Particle in Motion
39	Acceleration with Analysis
40	Implicit Differentiation: The Differential Method
41	Implicit Differentiation: The y' Method
42	The Second Derivative Implicitly
43	The Derivative of the Exponential Function
44	Inverse Functions and Derivatives
45	Review of Properties of Logarithms
46	Derivative of the Logarithmic Functions
47	Logarithmic Differentiation
48	More Practice with Combination Rules
49	Derivatives of Inverse Trigonometric Functions
50	Analysis Using First Derivatives
51	Analysis Using Second Derivatives
52	Absolute Extrema
53	Optimization Problems
54	Related Rates
55	Mean Value Theorem for Derivatives
56	Anti-Differentiation
57	The Chain Rule and Anti-Differentiation
58	U-Substitution
59	Anti-Derivatives with Initial Conditions
60	Particle Motion
61	Exponential Growth and Decay and Newton's Law of Cooling
62	Separable Differential Equations
63	Slope Fields
64	Slope Fields with Initial Value Problems
65	Definite Integrals
66	Approximate Area Using Numerical Methods
67	Riemann Sums - Midpoint
68	Net Area
69	Definite Integrals with Calculator
70	Properties of the Definite Integral
71	U-Substitution with Definite Integrals
72	Fundamental Theorem of Calculus - Part II
73	Velocity/Position Connection
74	Numerical Approximations: Trapezoidal Rule
75	Area Under a Curve
76	Area of a Region Between Two Curves
77	The Average Value
78	Volumes of Solids of Revolution - The Disc Method
79	Volumes of Solids of Revolution - The Washer Method
80	Volumes of Solids of Revolution - The Shell Method
81	Volume of Solids with Known Cross Sections
82	Arc Length and Surfaces of Revolution
83	Integration to Find Surface Area
84	Work Problems - Part A
85	Work Problems - Part B
86	Liquid Pressure and Fluid Force
87	Review of Integrals
88	Integration by Parts
89	Newton's Method
90	Indeterminate Forms and L'Hopital's Rule
91	Inverse Trigonometric Integrals
92	Velocity and Acceleration
93	Preparing for the AP Calculus AB Exam

Appendix VII

INTERNATIONAL ACADEMY OF SCIENCE
AP Calculus AB Exam Prep Course Curriculum

Lecture	Description
1	AP Exam/Derivatives (Chain Rule; Quotient Rule)
2	Equation of Tangent Line/Implicit Differential
3	Antidifferentiation
4	Antidifferentiation (u-substitution)
5	Limits
6	1st Derivative Analysis
7	f′ and f″ Analysis Part I
8	f′ and f″ Analysis Part II
9	Continuity and Differentiability
10	Related Rates
11	f′ and f″ Analysis Part III
12	More on f′ and f″
13	Fundamental Theorems of Calculus (I and II)
14	Position, Velocity, Acceleration, Speed
15	Inverse Functions/Chain Rule
16	Average Value
17	Definite Integrals/FTC I
18	Volumes of Solids
19	Differential Equations
20	Area Approximations
21	MVT, EVT, IVT
22	Free Response/Area and Volume
23	Fundamental Theorem of Calculus
24	Multiple Rep. of Functions Information Given as a Table (Data)
25	Implicit Differentiation/apcentral.com Released Questions
26	FTC I & II, g, g′, g″
27	Differential Equations/Slope Fields

Appendix VIII

INTERNATIONAL ACADEMY OF SCIENCE
College Entrance Math Preparation Course Curriculum

Lecture	Description	Lecture	Description
0	Introduction	29	Radicals
1	Sets	30	Radical Equations
2	Sets of Numbers	31	Distance and Mid-Point Formulas
3	Number Bases	32	Equation of a Line
4	Axioms	33	Conic Sections
5	Order of Operations	34	Functions
6	Absolute Value	35	Systems of Equations
7	Prime and Composite	36	Exponential and Log Functions
8	LCM and GCF	37	Sequences and Series
9	Fractions	38	Complex Numbers
10	Percents	39	Segment Lengths
11	Permutations	40	Congruent Angles
12	Combinations	41	Polygons
13	Probability	42	Similar Triangles
14	Variables	43	Pythagorean Theorem
15	Like Terms	44	30-60-90 and 45-45-90 Triangles
16	Linear Equations	45	Quadrilaterals
17	Statistics	46	Central and Inscribed Angles
18	Polynomials	47	Area and Perimeter
19	Factoring	48	Radians and Degrees
20	Quadratics	49	Trigonometric Definitions
21	Motion Problems	50	Graphs of Trigonometric Functions
22	Coin and Stamp Problems	51	Inverse Trigonometric Functions
23	Ratio Problems	52	Identities
24	Geometric Word Problems	53	Tips on Taking College Entrance Exams
25	Age Problems		
26	Work Problems		
27	Variation		
28	Exponents		