VERITY LEARNING

Tutoring & Education

Leonard E. James

Version 1.4

Sunday, June 20, 2021

Table of Contents

Table of Figures

1.0 Introduction

Verity Learning is a tutoring and education service from Lionhart Technologies, LLC. The name is derived from the Latin, veritas, meaning true. So the basic intent is to implement true learning. The logo contains, TRUTH → FREEDOM. This is an adaptation of a lambda expression from computer programming which means "truth leads to freedom". The idea comes from the Bible quoting Jesus Christ who said, "And you shall know the truth, and the truth shall make you free." (John 8:32)

True knowledge is the basis of freedom and a prosperous and joyous life. There is a excerpt from Hosea 4:6 which reads, "My people are destroyed for a lack of knowledge." Here the context speaks of a nation, ancient Israel, that rejected the source of true knowledge which ultimately led to national failure and captivity.

Therefore, the purpose of Verity Learning is to promote and support true education and learning. The initial focus will lie in the Science-Technology-Engineering-Mathematics (STEM) area. (See my biography below.) However, we expect to cover other areas as time goes on.

2.0 Leonard James – Brief Biography

I am the founder of Verity Learning. I have degrees in Chemistry (B.S.) and Mathematical Science(M.S.) I have over 55 years of professional experience in Chemistry, Engineering, Mathematics, Programming and Software Engineering. In addition my family has several teachers, my mother, father, two sisters and a sister-in-law were teachers. I benefited at a an early age from the my father's teaching; he was a mathematics teacher and he taught me many things when I was less than ten or twelve years old that I did not see again academically until graduate school.

3.0 Foundational Approach

One of the key things my father taught me was not to view a particular subject in isolation from other subjects in what I now call "silo learning". In silo learning each subject is viewed as a world to itself. This is particularly problematic concerning mathematics. Many students say that mathematics is not relevant to everyday life, so there is no need to learn it. However, many activities involve knowing mathematics, like dealing with credit card and mortgage interest, filing taxes or even household budgeting. From my own professional experience I have found it difficult to work as a chemist or engineer without a good foundation in mathematics. Also, in life it is good to understand history, civics and other subjects to be a functional and productive adult.

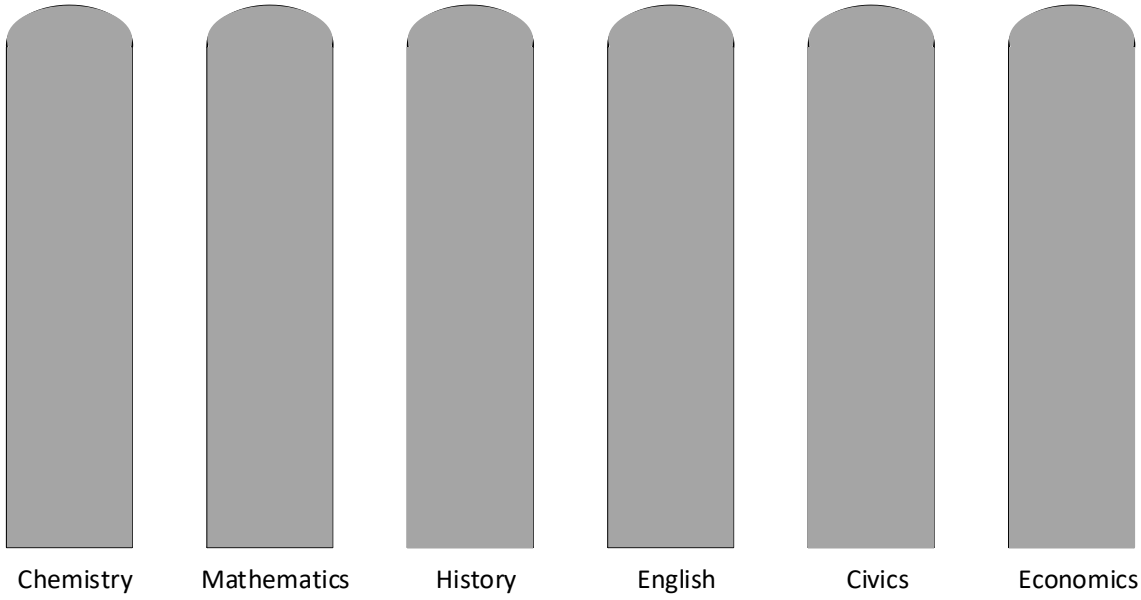

Figure 1. Silo Illustration

However, silo learning hinders the required interdisplinary nature of learning. One cannot successfully understand chemistry without mathematics or understand civics without history. Understanding chemistry, mathematics and English is enhanced by knowing the history behind the concepts in these areas. All of these subjects and others impact our lives and society. Therefore, the teaching and tutoring must make the subject matter relevant to everyday living.

4.0 Basis of Thinking & Reasoning

When I entered graduate school in mathematical science in 1977 I ran across a book by Daniel Solow entitled "How to Read and Do Proofs: An Introduction to Mathematical Thought" (Solow, Daniel, 6th edition, John Wiley & Sons, July, 2013, lster edition). The question is, "How do you prove something; how can you reason correctly?" According to Dr. Solow there are two keys, definitions and assumptions, that I have come to see that establishs a third, context.

4.1 Definitions

The process begins by clearly stating the definitions of the terms under consideration. Basically, if any person or group of people are going to prove something, the first step is to define the concepts involved. The be effective a parties must have common definitions or no progress can be made. We have to know what we are considering.

This is often where communication and understanding breaks down. If a term is used and one party has a different understanding of its meaning than another party, communication and reasoning is simply not possible without a clear and common definition of the terms.

For example, the word compact has four or more definitions.

4.1.1 Varying Definitions

Different people define things differently. Currently, in America we do not have common definitions of such words as freedom, democracy and liberty.

Worldwide, people of different ethnicities, religions and philosophies define things in differing ways. In World War II it was reasonable for Japanese pilots to crash their planes into allied ships. Currently, there are those who, based on the way they define their god's commands, see strapping a bomb to themselves and stepping into a crowd of people a blowing up themselves and those around them as a reasonable and desirable act.

4.2 Assumptions

An assumption is a statement that is taken for granted as true **without proof**. Most of us first encounter assumptions in a high school geometry class in proving theorems. Assumptions are the givens; they are the starting point.

4.2.1 Geometry Example

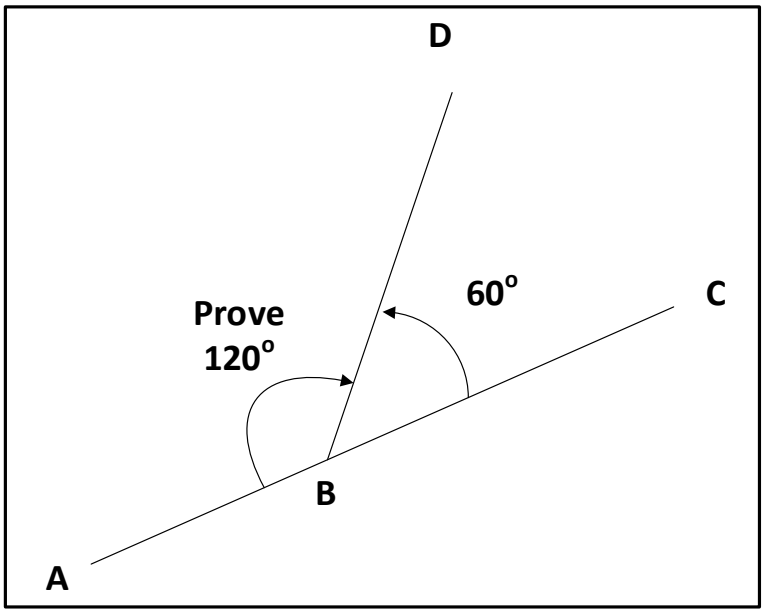

Figure 2. Supplementary Angle

A geometric theorem might go like this. (See Figure1.)

1. Given two straight lines AC and BD intersecting at the point, B.

2. The angle CBD is 60°.

Prove: Angle ABD is 120°.

The assumptions here are the givens. We do not prove that the lines are straight or that they intersect. We do not prove that the angle CBD is 60°.

4.2.2 Basis of Assumptions

As with definitions different socioeconomic groups make different assumptions. Assumptions are those factors that are taken for granted. These assumptions lead to different expections and behaviors. There was a time that one could assume that most children lived with both parents. In the early 1960s, 75% of African-American families with children had a father in the home. Today it is 30% or less. The impact of this fact leads to different behavior and expections. For example, children growing up in this environment do not assume they will marry before becoming parents.

4.3 Context

Definitions and assumptions together form a context for reasoning and thinking about a conjecture and proving whether it is true or false. The basis for reasoning is valid only within the context of the definitions and assumptions involved. If these do not hold, we cannot proceed in a valid way. Deceiption and misunderstanding occurs when there are inconsistencies in definitions, assumptions and conttexts.

4.3.1 Modified Geometry Example

Take a look at Figure 3. It is a modification of Figure 2. We can no longer apply the same reasoning. The line, AC, is no longer a straight line. The assumptions for the previous proof no longer hold and we cannot use the same reasoning. Actually it is still possible to draw some conclusions about the angles, but we must use more complex mathematics involving calculus. The context has changed.

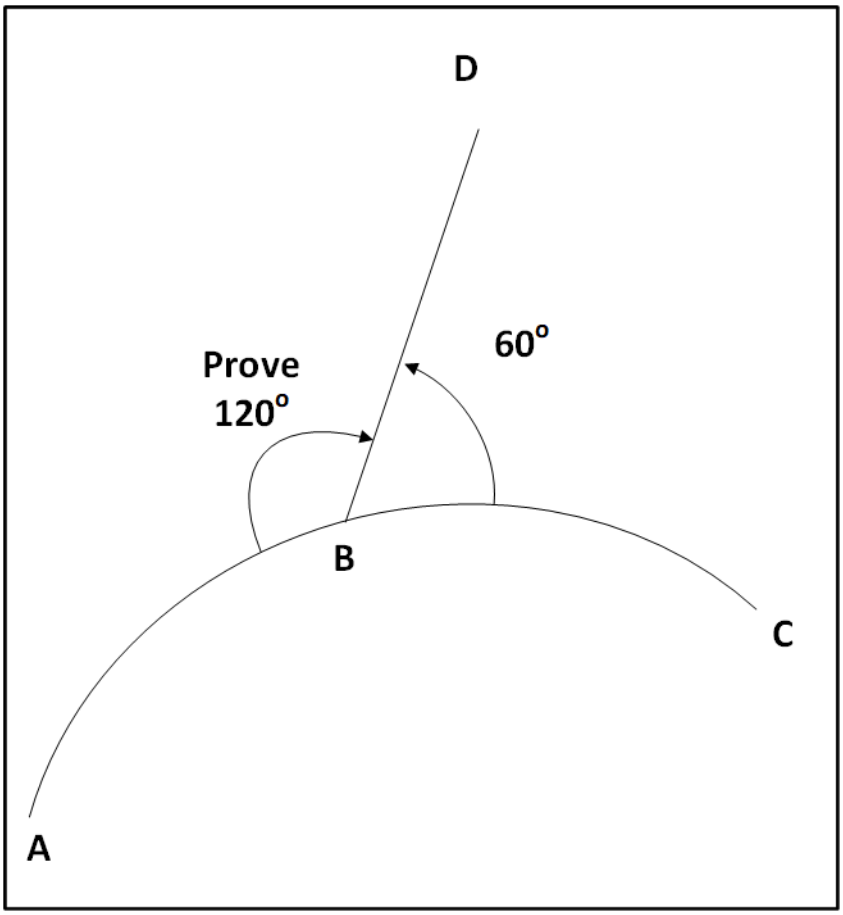

Figure 3. Modified Assumption

4.3.2 Problem with Misapplied Definitions & Assumptions

Often we use words with multiple definitions. We can fall into a logical trap by using the wrong definition in our reasoning. I once had a job providing technical support for a computer system that was used to solve business problems. The case involved the use of the word, process. In the context of the problem there were two definitions of the word.

Definition 1

A series of actions or steps taken in order to achieve a particular end. (Oxford Dictionary)

Definition 2

A process is an instance of a computer program that is being executed. (Wikipedia)

I recall that the support team was discussing an issue associated with a program that had a problem and we had to use the word, process, in our

discussion where both defintions were involved. We had be sure that we clearly understood which definition to apply when the term was used.

4.3.3 Divine Context

One of the greatest challenges of the 21st century is acceptance of an overall, governing Divine context. God created everything. He engineered the universe. All knowledge flows from this fact. Any reasoning that ignores this is inherently flawed and leads to believing and acting on lies. Therefore, the objective in developing the Verity Learning application and program is base it on God's Divine Context.

5.0 The Abstract vs. the Concrete

A problem that arises for many people concerns the use of abstractions. This is particularly an issue in mathematics and some sciences. Many people deal with arithmetic in the early grades, but experience difficulties when taking classes in geometry and algebra. The root of the problem is the use of abstractions in the material. Algebra introduces variables, x and y. Geometry deals with proofs and theorems.

Abstractions are powerful in dealing with more advanced subjects, but are real stumbling blocks for those who cannot grasp abstract concepts easily. They enable us to express powerful ideas at a high level that have multiple applications in broad areas. In fact, the application of abstractions often cross the boundaries of the silos mentioned above.

One way to view an abstraction is to see it as a blueprint for a house. The blue print is not the house; it is the plan for a house. When a person goes to a builder he may choose the basic plan. Then, he may want it built by reversing the plan and making other minor modifications to the plan. The colors of the bricks, walls, carpet and other details might vary from one house built from the blueprint to another. Yet the final product is still based on the original blueprint. The blueprint is the abstraction; the houses constructed from are concrete manifestations of it. Confusion can result as the process moves from the abstraction to the concrete and one must train his mind to deal with the process.

6.0 Role of Logic

The name is Verity Learning. We seek to teach and facilitate the knowledge of the truth. How do we know the truth? When studying science and mathematics we use proofs. Proofs involve logic to establish that a proposition is true. The first encounter most people have with proofs is in a geometry class. As time goes on proof techniques are key parts of studying law and philosophy.

Sorting through misapplied, misleading or contradictory definitions and assumptions are part of the problem. Consider the following.

6.1.1 The Puzzle of the Two Doors

My father as he was teaching me the principles of logic told me about the Puzzle of the Two Doors.

> *You are a prisoner in a room with 2 doors and 2 guards. One of the doors will guide you to freedom and behind the other is a hangman --you don't know which is which.*
>
> *One of the guards always tells the truth and the other always lies. You don't know which one is the truth-teller or the liar either.*
>
> *You have to choose and open one of these doors, but you can only ask a single question to one of the guards.*
>
> *What do you ask so you can pick the door to freedom?*
>
> - *The Puzzle of the Two Doors*

There are chains of logic that lead the way to escape this dilemma without fail. They are fairly complex and not without some controversy and disagreement. However, the proposition that a liar always lies and a truth teller always tells the truth gives rise to the puzzle and its answers. We don't have time or space to go through the details here. You can find discussions to the logic at the following links.

https://puzzling.stackexchange.com/questions/2188/two-doors-with-two-guards-one-lies-one-tells-the-truth

https://puzzling.stackexchange.com/questions/7954/logic-explanation-in-two-doors-answer

The point is that deception occurs in the context of confusion and half truths.

6.2 Reductio ad Absurdum

My father taught me much about logic and proofs. His teachings were reenforced by years of education and professional experience as a technical professional. The Latin expression, *reductio ad absurdum*, means "reduction to absurdity". Formally, it is the basis for the contrapositive method of proof. Mathematical proofs usually start with a set of assumptions or givens that logically lead to the conclusion that statement to be proved is true. The contrapositive method starts by assuming that the givens are false and then showing that this assumption leads to a contradiction, that is, reduces to the the absurd.

From this we can learn that contradictions show us that something is wrong with our reasoning. Once we have two statements that contradict each other, one or the other is not true. Sometimes neither is true. Many of the problems we experience result from believing and attempting to live by contradictory ideas.

6.2.1 Moral Equivalence

One of the most difficult ideas to confront is the moral equivalence. The world is filled with religions, philosophies and idealogies that are not consistent with each other. In fact they contain contradictory ideas. Clearly they cannot ***all*** be right. Some ideas are wrong or even dangerous and destructive. Yet many people try to hold that all these conflicting and contradictory ideas can be somehow reconciled. Each one represents a "tree" discussed in Matthew 7. They define ways of thinking, codes of behavior and lifestyles. Anyone who tries to hold them to be morally equivalent will be confused and even dysfunctional. They can not and are not all true. Spiritual, mental and physical health comes from knowing and embracing the truth.

6.3 You Shall Know the Truth

The solid foundation rests on truth. Truth can be difficult to discern. Often we, as human beings, do not want to know the truth.

John 8:31-32 New King James Version (NKJV)

31 Then Jesus said to those Jews who believed Him, "If you abide in My word, you are My disciples indeed.

32 And you shall know the truth, and the truth shall make you free."

7.0 Our Approach

As previously stated our plan is the start with subjects in the STEM areas. The initial offerings will address the courses algebra and basic mathematics. We have examined the mathematics and science curricula and requirements for several states, TX, MS, OH and VA. We extracted a set of topics from these sources and arranged them in sequences for the courses. The topics for Algebra I are shown in a section below.

7.1 Course Tests

Each course will have a number of multiple choice tests of difference types:

Exam Type	Description
Sample	Sample exam made available to registered users and prospective students or parents.
Pre-Requisite	An exam given to access whether a student has sufficient skills to begin a course or tutoring.
Diagnostic	An exam to diagnose specific problem areas or topics.
Exercise	An exam given as part of a tutorial or teaching session.

Graded	An exam given as part of the course evaluation which will be used as part of the grading assessment.
Final	A comprehensive exam given to assess overall mastery of the course topics.

The questions will have one or more correct options. Each option will be designed to assess mastery of one or more topics. The posted test analysis will provide guidance on problem areas.

7.2 Current Subjects

- Mathematics
- Computer Science
- Natural Science
- Chemistry
- Physics
- Astronomy

7.3 Algebra I Topics

The following pages gives the current list of topics for Algebra I.

Algebra I Topics

SequenceNumber	Topic Title
1000000	Critical Thinking, Logic and Reasoning
1001000	Definitions, assumptions and context
1001001	Definition
1001002	Assumption
1001003	Context
1002000	Abstractions
1003000	Concrete Manifestations
1004000	Logic
1004100	Logic - Deductive Reasoning
1004110	Logic - Deductive Reasoning, Definition
1004120	Logic - Deductive Reasoning, Assumption
1004130	Logic - Deductive Reasoning, Context
1004140	Logic - Deductive Reasoning, Quantifier
1004141	Logic - Deductive Reasoning, Universal Quantifier
1004142	Logic - Deductive Reasoning, Existential Quantifier
1004143	Logic - Deductive Reasoning, Universal-Existential Quantifier
1004200	Logic - Inductive Reasoning
1004300	Logic - Abductive Reasoning
2000000	Numbers
2001000	Numbers - Sets and types
2002000	Numbers - Natural numbers
2003000	Numbers - Integers
2003001	Integers - Perfect square
2004000	Numbers - Rational numbers
2004001	Fractions - Addition and subtraction
2004002	Fractions - Multiplication and division
2004003	Fractions - Division by
2004004	Fractions - Conversion to and from decimal form
2004005	Fractions - Numerator
2004006	Fractions - Denominator
2004007	Fractions - Proper
2004008	Fractions - Improper
2004009	Fractions - Mixed numbers
2004010	Fractions - Mixed Number Conversions
2004011	Fractions - Complex
2004012	Fractions - Equivalent
2004013	Fractions - Lowest Terms
2005000	Numbers - Real numbers
2006000	Numbers - Complex numbers
2007000	Numbers - Classify numbers
2008000	Numbers - Constants
3000000	Integer Factorization
3001000	Integer Factorization - Prime number
3002000	Integer Factorization - Composite number

Algebra I Topics

SequenceNumber	Topic Title
3003000	Integer Factorization - Greatest Common Divisor (GCD)
3004000	Integer Factorization - Least Common Multiple (LCM)
4000000	Ratios, rates and proportions
4001000	Ratios - Equivalent ratios
4002000	Ratios - Unit rate
4003000	Ratios - Unit price
4004000	Ratios - Solve proportions
4005000	Ratios - Scaling, including drawings
5000000	Percents
5001000	Percents - Convert between percents, fractions and decimals
5002000	Percents - Solve percent equations and problems
5003000	Percents - Percent of change
5004000	Percents - Percent of a number: tax, discount and more
5005000	Percents - Application of multiple percentages
6000000	Measurement
6001000	Measurement - Conversions
6002000	Measurement - Compound units of measure
6002001	Measurement - Convert rates and measurements: English units
6002002	Measurement - Convert rates and measurements: metric units
6002003	Measurement - Cross conversions
6003000	Measurement - Precision
6004000	Measurement - Greatest possible error (GPE)
6004001	Measurement - Percent error
7000000	Set theory
7001000	Set theory - Subsets
7002000	Set theory - Operations, Union
7003000	Set theory - Operations, Intersection
7004000	Set theory - Universal set
7005000	Set theory - Complement set
7006000	Set theory - Empty set
7007000	Set theory - Mappings
7007001	Set theory - Mappings, Relations
7007002	Set theory - Mappings, Functions
7007003	Set theory - Mappings, One-to-one correspondence
8000000	Numerical Operations
8001000	Numerical Operations - Closure
8002000	Numerical Operations - Binary
8002001	Numerical Operations - Binary, Addition and subtraction
8002002	Numerical Operations - Binary, Multiplication and division
8002003	Numerical Operations - Binary, Comparison
8002004	Numerical Operations - Sorting
8003000	Numerical Operations - Unary
8003001	Numerical Operations - Unary Negation
8003002	Numerical Operations - Unary Plus

Algebra I Topics

SequenceNumber	Topic Title
8003003	Numerical Operations - Absolute Value
8003004	Numerical Operations - Order and priority
8003005	Numerical Operations - Taking roots
9000000	Exponents
9001000	Exponents - Base multiplication and division
9002000	Exponents - Power rule
9003000	Exponents - Rational powers and roots
9003001	Exponents - Logarithms
9004000	Exponents - Scientific notation
9004001	Exponents - Scientific notation, positive exponents
9004002	Exponents - Scientific notation, negative exponents
9004003	Exponents - Scientific notation, addition and subtraction
9004004	Exponents - Scientific notation, multiplication and division
9004005	Exponents - Scientific notation, comparisons
10000000	Algebraic Properties
10001000	Algebraic Properties - Commutative property
10002000	Algebraic Properties - Associative property
10003000	Algebraic Properties - Distributive property
10004000	Algebraic Properties - Properties of equality
10005000	Algebraic Properties - Equivalent equations
11000000	Algebraic and numerical expressions
11001000	Expressions - Definitions
11001001	Expressions - Definition, constant
11001002	Expressions - Definition, variable
11001003	Expressions - Definition, operation
11001004	Expressions - Definition, relational operation
11001005	Expressions - Definition, grouping
11002000	Expressions - Evaluation
11002001	Expressions - Operator precedence
11003000	Expressions - Polynomials
11003001	Expressions - Polynomials, degree
11003002	Expressions - Polynomial addition and subtraction
11003003	Expressions - Polynomial multiplication and division
11003004	Expressions - Polynomial processing and evaluation
12000000	Equations and inequalities
12000001	Equations and inequalities - Solving
12001000	Equations
12002000	Inequalities
13000000	Equations, Linear
13000001	Linear equations - Two variable slope-intercept form
13000002	Linear equations - Two variable standard form
13001000	Linear equations - Systems
14000000	Quadratic equations
14001000	Quadratic equations - Solve by completing the square

Algebra I Topics

SequenceNumber	Topic Title
14002000	Quadratic equations - Solve using the quadratic formula
14002001	Quadratic equations - Discriminant > 0
14002002	Quadratic equations - Discriminant = 0
14002003	Quadratic equations - Discriminant < 0
15000000	Exponential equations
15000001	Exponential equations - Logarithmic solutions
16000000	Exponents - Fractional, radicals and roots
16000001	Exponents - Radical equations
17000000	Finance
17100000	Finance - Budgeting
17100100	Finance - Income
17100101	Finance - Wages and Salaries
17100102	Finance - Commissions
17100103	Finance - Savings & Checking, Interest
17100200	Finance - Expense
17100201	Finance - Expense, Housing
17100202	Finance - Expense, Utilities
17100203	Finance - Expense, Automobile
17100204	Finance - Interest, Simple
17100205	Finance - Interest, Compound
17100220	Finance - Taxation
17100221	Finance - Taxation, Income
17100222	Finance - Taxation, Property
17100223	Finance - Taxation, Sales
18000000	Geometry
18100000	Geometry - Point
18200000	Geometry - Line
18300000	Geometry - 2D
18300001	Geometry - Angle
18300100	Geometry - Quadrilateral
18300101	Geometry - Parallelogram
18300102	Geometry - Rectangle
18300103	Geometry - Square
18300200	Geometry - Triangle
18300201	Geometry - Triangle, Scalene
18300202	Geometry - Triangle, Isosceles
18300203	Geometry - Triangle, Equilateral
18300204	Geometry - Triangle, Right
18300205	Geometry - Triangle, Oblique
18300206	Geometry - Triangle, Acute Oblique
18300207	Geometry - Triangle, Obtuse Oblique
18300208	Trigonometry - Pythagorean theorem
18300300	Geometry - Circle
18300301	Geometry - Area, Circle

Algebra I Topics

SequenceNumber	Topic Title
18300302	Geometry - Perimeter, Circle
18400000	Geometry - 3D