

ITALIAN STEM CURRICULUM

PARTNER:	Liceo Scientifico "Sensale"	COUNTRY:	Italy

SUBJECT:	MATHEMATICS	LEVEL:	Secondary
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Strands and strand units in the MATHEMATICS curriculum:

* Highlight in **green** the most motivating or meaningful strand units for teachers and highlight in **red** those strand units that may be more difficult for our students.

STRAND UNITS	FIRST AND SECOND YEAR (AGE 14-15)	THIRD YEAR (AGE 16)
Arithmetic and algebra	<ul style="list-style-type: none"> Numerical Sets: N, Z, Q, R (<u>first year</u>) The set N of natural numbers; fundamental operations powers; properties of powers; prime numbers; Prime factorization; Greatest common divisor and the least common multiple of two or more numbers; problems on G.C.D. and l.m.c.. Numerical proportions: applications. Percentages. The set Z relative integers and the set Q of rational numbers; operations in Q. the set R of real numbers. Literal calculus (<u>first year</u>) Monomials; polynomials: operation with polynomials. Polynomial factoring with different methods and factoring with combined methods; G.C.D. and l.m.c. of polynomials. Algebraic fractions: simplification and operations. Linear equations and inequalities; systems of linear equations and inequalities (<u>first year</u>) Linear equations with integers, literal equations; fractional equations. Linear systems: solved using 	<ul style="list-style-type: none"> Quadratic inequalities; rational inequalities; irrational equations and inequalities; absolute value equations and inequalities; higher than second grade inequalities; systems of inequalities. Functions: definition; properties; analysis of particular functions. Successions. Progressions. The cartesian plane: coordinate systems, distance between two points, midpoint, centre of gravity and geometric loci. The straight line: explicit and implicit form; angular coefficient and intercept; graphical representation; intersection, parallelism and orthogonality; distance between a point and a line; families of straight lines. The circumference in the cartesian plane as a geometric locus; reciprocal positions of a straight line and a circumference: algebraic and geometric results; tangent lines; families of circles; classical problems: the rectification of the circumference and squaring the circle; Pi. Polarity.

	<p>different methods.</p> <p>Problems which can be solved by linear equations with one and two unknowns.</p> <p>Algebraic and graph solution to a linear inequality.</p> <ul style="list-style-type: none"> Cartesian plane: straight lines and curved lines(<u>first and second years</u>) Cartesian plane. Equation of a straight line on the cartesian plane. Conditions of parallelism of lines and of perpendicularity of two lines. The parabola: study and graph, problems on parabola. Arithmetical radicals(<u>second year</u>): arithmetical radicals, operations with radicals, rationalization of the denominator in a fraction. Quadratic and higher than quadratic equations, systems and inequalities (<u>second year</u>)– quadratic equations, equations containing integers, with fractions and letters. Application of quadratic equations to the solution of problems. Parametric equations. Equations higher than quadratic Irrational equations. Quadratic and higher than quadratic systems . Quadratic inequalities with integers and inequality systems. Solving algebraic and geometric problems using quadratic and higher than quadratic equations. 	<ul style="list-style-type: none"> The parabola in the cartesian plane as a geometric locus: definitions, properties and graphical representation; conditions to determine the equation of a parabola; reciprocal positions of a parabola and of a line; tangent lines. Polarity. Families of parabolas. Ellipse in the cartesian plane as a geometric locus: definitions and properties; graphical representation; conditions to determine the equation of the ellipse; reciprocal positions of an ellipse and a line; tangent lines. Hyperbola in the cartesian plane as a geometric locus: definitions and properties; canonical equation, equilateral hyperbola , homographic function; graphic representation; conditions to determine the equation of the hyperbola; reciprocal positions of a hyperbola and a line; tangent lines. Elements of descriptive statistics.
The foundations of Euclidean geometry in the plane	<ul style="list-style-type: none"> Fundamental geometric entities (<u>first year</u>) Congruence in the plane. Comparisons operations between segments and angles. Study of triangles and polygons (<u>first year</u>) Congruence criteria for triangles. Disequalities between the elements of a triangle. Notable points of triangles. polygons: generalities. Notable quadrilaterals : trapezoid; parallelogram; rhombus; rectangle; square. Parallelism and perpendicularity (<u>first year</u>) 	

	<ul style="list-style-type: none"> • Straightlines-generalities • perpendiculars,axis of a segment; geommetric loci. Parallel straight lines, Euclide's axiom; parallelism criteria. • Circumference and circle (<u>first year</u>) Definitions and properties of a circumferenceand of a circle. Anglesat the circumference. • Equivalence of polygons, Pythagorean and Euclidean theorems (<u>second year</u>) Equidecomposability of polygons. Transformation of polygons.Theory of measurement. Phythagorean theoremand first and second Euclide's theorem:statements, demonstrations and applications. Metrical shapes. • Geometric transformations; Thales theorem(<u>second year</u>) Proportional magnitudes. Thalet's theoremand its applications • Similarities(<u>second year</u>) Similaritiesbetween flat shapes. Similar triangles and similarity criteria. Similar polygons. Applications of similarity. Elements of flat geometry– Problems on the application of algebra to geometry. 	
Relations and functions	<ul style="list-style-type: none"> • Elements of mathematical logic (<u>first class</u>) • Elements of set theory (<u>first class</u>) Relations and functions (<u>first and second class</u>) Equivalence relations and order relations. Injetcive, surjective and bijective functions; representation of the functions with a double entry table and cartesian diagrams. 	
Data and predictions	<ul style="list-style-type: none"> • Statistics: representation and analysis of data, mean values and and measures of variability (<u>first class</u>) • Probability: classical and statistical probability; concept of mathematical model (<u>second class</u>) 	
Elements of computer science	<ul style="list-style-type: none"> • Instruments in computer science for mathematical objects Power point – Excel – Word • Algorithms(first and second year) 	

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DIGIT GAME preference strand units:

FIRST AND SECOND YEAR (AGE 14-15)	THIRD YEAR(AGE 16)

SUBJECT:	SCIENCE: EARTH SCIENCE, BIOLOGY AND CHEMISTRY	LEVEL:	Secondary
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STRAND UNITS	FIRST AND SECOND YEAR (AGE 14-15)	THIRD YEAR (AGE 16)
Magnitudes and measurements	<ul style="list-style-type: none"> - The scientific method. - Physical magnitudes and their measure. - International System of Units. - Prefixes of multiples and submultiples of a unit measurement - Scientific notation - Intensive and extensive physical magnitude - Mass and weight. - Density - Heat and temperatures - Temperatures, thermometric scales. - Forms of energy: heat, kinetic energy, potential energy, chemical energy. - Unit of measurement of energy: joule and calory 	
The physical transformation of matter	<ul style="list-style-type: none"> - Physical and chemical properties - Physical transformations and chemical transformations . - States of aggregation of matter - Heat and temperature. State changes. - Heating and cooling curves. - Particle theory of matter - Gases and vapors - Pure substances - Homogeneous and heterogeneous mixtures - Solutions - The heating curve of pure substances and of mixtures - Thermal break and latent heat - Melting and boiling temperature of a pure substance. - Separation techniques of mixtures - filtration, centrifugation, cromatography, extraction, distillation 	
The chemical transformation of matter	<ul style="list-style-type: none"> - elements and compounds - Lavoisier's law of conservation of mass -law of conservation of energy -Proust's law of definite and constant 	<ul style="list-style-type: none"> - Chemical reactions - Balance and reaction equations in a chemical reaction - Stoichiometric calculations, limiting

	proportions. - Dalton's atomic theory - Dalton's law of multiple proportions - Reagents and products of a chemical reaction	reagent and excess reagent - various types of reaction: synthesis, decomposition, simple exchange, double exchange (precipitation, gas formation, neutralization) - Redox reactions - Speed of reaction and influencing factors. - The energy in chemical reactions: endothermic and exothermic reactions. - Green chemistry
The language of chemistry	- Names and symbols of the elements - Relative atomic mass and molecular mass - Periodic table of elements - Metals, semimetals, nonmetals and their properties - Representation of atoms and molecules. - Chemical quantity: mole - Percentage composition and formulas.	
Great ideas of Earth Science	- Solar system formation. - The structure of planet Earth. - the Earth system and the celestial spheres. - the age of the Earth. - Resources. - The tasks of Earth Science. - Defense from natural risks. - The environment safeguarding.	
The celestial environment	The characteristics of stars and their brightness - Light and electromagnetic radiation. - Position of stars. - stellar evolution. - Galaxies. - the origin of the Universe.	
The solar system	- geocentric and heliocentric - the sun. - Kepler's laws. - Law of universal gravitation. - the characteristics of the planets of the solar system.	
The Earth and the Moon	- The shape and the dimension of the Earth. - Motions of the Earth. - geographic coordinates measurement. - Measuring time, day, year, Gregorian reform of calendar. - theories about the origin of the Moon. - Motions of the Moon and their consequences - Moon phases and eclipses.	

Atmosphere and meteorological phenomena	<ul style="list-style-type: none"> - Air composition. - Subdivision of the atmosphere. - The origin of the atmosphere. - Earth warming - Atmospheric pollution - Atmospheric pressure - Winds and the global air circulation - Humidity in air - Meteorological phenomena and their causes - Weather forecast - Climate and its changes - Climate elements and factors - The principal types of climate and their geographical distribution - Existing relations between climate conditions and vegetation - Types of climate in Italy. - Climate changes and global warming. 	
Oceans and seas hydrosphere	<ul style="list-style-type: none"> - Distribution of water in the natural basins of our planet - Characteristics of sea waters - Differences between oceans and seas - Characteristics of ocean floors - Origin and characteristics of wave motion - Causes and rhythm of tides - Origin of sea currents and their importance for climate and life on our planet - Pollution of sea waters 	
The structure of an atom	<ul style="list-style-type: none"> - atom, protons, neutrons, electrons, atomic number, mass atomic number, isotopes. - Electron configuration and the chemical properties of an element. - Ionic bond, pure covalent and heteropolar bond, hydrogen bond. - Water and its chemical and physical properties, life depends on water properties, water cycle - Properties of aqueous solutions. 	<ul style="list-style-type: none"> - Electrical nature of matter, discovery of electron, of proton and of neutron, first atomic models - Components of nucleus, isotopes, applications of radioactive isotopes - Discovery of periodicity of elements. - Energetic levels - Energetic sublevels - Distribution of electrons and periodic table - Periodic properties - Atom according to quantum mechanics, electronic configuration of the elements, atomic and molecular orbitals - Chemical bond, pure covalent and polar bond, ionic bond, dative covalent bond, metal bond, hydrogen bond.
Chemical inorganic compounds	-	<p>Classification of inorganic compounds, oxides, hydroxides, acids and salts.</p> <ul style="list-style-type: none"> - Calculation of oxidation number - Nomenclature of inorganic compounds - Structural formulas

Solutions	<ul style="list-style-type: none"> - solutions. - Concept of miscibility. - Concentration of a solution, %m/m, %m/V, %V/V 	<ul style="list-style-type: none"> - Concentration of solutions, Molarity, molality, mole fraction. - Process of solubilization. - Solutions di electrolytes - Properties of solutions: cryoscopic lowering, boiling point - elevation, osmotic pressure, vapor pressure.
Biology is the science living beings	<ul style="list-style-type: none"> - Characteristics of living beings. - The cellular organization, evolution and variety of beings 	<ul style="list-style-type: none"> - biodiversity - Bacteria metabolism: bacteria producers, nitrogen fixation bacteria, nitrifiers, denitrifiers, decomposers; different forms of bacteria; characteristics of Archaea. - The organization of protists; - The characteristics of terrestrial plants; non vascular plants; the organization of vascular plants; classification of vascular plants: lycopods, equisetia, ferns, spermatophyta, gymnosperms, angiosperms. - Characteristics and classification of fungi; lichens - Characteristics of animals; embryonic development, hierarchical organization and the structure of the body; invertebrates. - The characteristics of chordates and of vertebrates; the characteristics and variety of fish; characteristics and variety of amphibians. - Characteristics and variety of reptiles, characteristics and variety of birds; characteristics and variety of mammals.
Biomolecules	<ul style="list-style-type: none"> - Organic composites, polymers and monomers, reactions of condensation and hydrolysis - Composition, structure and function of monosaccharides, olygosaccharides, polysaccharides. - Composition, structure and properties of the aminoacids, peptide bonds polypeptide chains; protein primary, secondary, tertiary and quaternary structures; relations between structure and specificity of proteins; protein denaturation. - Properties of lipids; composition, structure and functions of fats, oils, phospholipids, glycolipids; functions of carotenoids, steroids, cholesterol, waxes - The structure of nucleotides; arrangement of nucleotides in the DNA 	

	and RNA molecules; function of nucleic acids.	
The cell is the elementary unit of life	<ul style="list-style-type: none"> - The importance of the ratio surface/volume in cells; observing through a microscope. - General characters and specialized structures of the prokaryotic cells. - The organization of the internal membranes and of the organelles inside eukaryotic cells. - Nucleus and genetic information, ribosomes and protein synthesis. - Rough and smooth endoplasmic reticulum and Golgi apparatus - Organelles which transform energy: mitochondrions and chloroplasts. - Microfilaments, intermediate filaments, microtubules, cilia and flagella. - Extracellular structures and cells adhesion. 	
Energetic metabolism	<ul style="list-style-type: none"> - Heterotrophic organisms. - Autotrophic, photosynthetic and chemosynthetic organisms. - Cellular respiration and chlorophyll photosynthesis. - Alcoholic fermentation and milk fermentation. - C4 and CAM plants. 	
The cellular division in prokaryots and eukaryots	<ul style="list-style-type: none"> - Cellular division and control signals; binary fission of prokaryots. - Cellular cycle; DNA replication and chromatid pairs; stages of mitosis cytodieresis; mitosis and asexual reproduction. - Fertilization and meiosis; life cycles of haplontic, diplontic, haplodiplontic organisms; stages of meiosis I and meiosis II. - Sexed reproduction and the variety of beings - Karyotype and species; intraspecific variability and sexed reproduction. 	
Classical and molecular genetics		<ul style="list-style-type: none"> - The laws of Mendel. - DNA: composition, structure and properties. - Human Genetics. Study of some hereditary diseases. - The Genetic code. Mutations. - Protein synthesis - Regulation of gene expression - Engineering and genetic manipulation.

		GM food. Cloning. The human genome. Ecological, social and ethical implications.
Birth of life and evolution	<ul style="list-style-type: none"> - Fossils, rocks and history of life - The first stages of evolution: single-celled prokaryotic organisms - Appearance of photosynthetic organisms and the changes in the atmosphere - The evolution of eukaryotic cells and of multicellularity - Classification of living beings from the evolution viewpoint: phylogenesis and phylogenetic trees. - Theories about the origins of life. - Endosymbiosis theory. - Fixist theories, Lamarck - Catastrophism. - The theory of evolution by natural selection; evolution evidence. 	-

DIGITGAME preference strand units:

FIRST AND SECOND YEARS (AGE 14-15)	THIRD AND FOURTH YEARS (AGE 16)

SUBJECT:	SCIENCE: PHYSICS	LEVEL:	Secondary
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Strands and strand units in the PHYSICS AND CHEMISTRY curriculum:

* Highlight in **green** the most motivating or meaningful strand units for teachers and highlight in **red** those strand units that may be more difficult for our students.

STRAND UNITS	FIRST AND SECOND YEAR(AGE 14-15)	THIRD YEAR(AGE 16)
Physical laws and theories of errors	Physical magnitudes(first year) Measurements and errors(first year) Physical laws and methods of representation(first year)	
Vectors	Vectors – operations using vectors(first year)	
Mechanics	Kinematics – motions(rectilinear motion and motion on a plane)(first year) Dynamics – different types of forces(first year) Laws of dynamics and their application in real life (second year) Work and energy - properties and transformation of energy(second year) Statics- equilibrium of rigid bodies(first year) Cardinal equations of statics	Uniform motion and e uniformly variable motion – relations and laws; falling bodies. Vectors theory: operations/calculations; algebraic and geometric analysis Two-dimensional motion; uniform circular motion; main orders of magnitude, centrifugal and centripetal force; motion of a bullet; harmonic motion. Forces and motion: principles of dynamics; friction; apparent forces. Work and energy: work done by a variable force and by a constant force Potential energy and kinetic energy; the principle of conservation of mechanical energy; power. Quantity of motion and shocks; impulse of force; centre of mass Rotatory motion and balance; rigid bodies, translation and rotation; momentum of force and angular momentum. Statics: vector character of forces Gravitation: terrestrial and celestial physics; Kepler's laws; the universal law of gravitation; the value of G constant; inertial and gravitational mass; gravitational field; gravitational potential energy.
Fluids	Hydrostatics and hydrodynamics: pressure and equilibrium of liquids(second year)	Fluid statics: density, specific weight; fluid pressure; Pascal's and Stevin's laws; communicating vessels; Archimedes's principle; atmospheric pressure; measurement of atmospheric pressure. Fluid dynamics: electricity and ampacity;

		Bernoulli's equation; Venturi effect; viscosity.
Temperature and heat	Temperature and heat- heat transfer(second year)	Elements of thermology, thermometry and study of the behaviour of gases
Waves geometric optics	Laws of reflection Reflection Mirrors Curved planes/surfaces Lenses	

DIGITGAME preference strand units:

FIRST AND SECOND YEARS (AGE 14-15)	THIRD AND FOURTH YEARS (AGE 16)