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6 CHAPTER

MATHEMATICAL COMPETENCE AND COMPETENCE IN SCIENCE, TECHNOLOGY AND ENGINEERING

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Mathematical competence and competence in science, technology and engineering

A Mathematical competence is the ability to develop and apply mathematical thinking and insight in order to solve a range of problems in everyday situations. Building on a sound mastery of numeracy, the emphasis is on process and activity, as well as knowledge. Mathematical competence involves, to different degrees, the ability and willingness to use mathematical modes of thought and presentation (formulas, models, constructs, graphs, charts).

Knowledge

Necessary knowledge in mathematics includes a sound knowledge of numbers, measures and structures, basic operations and basic mathematical presentations, an understanding of mathematical terms and concepts, and an awareness of the questions to which mathematics can offer answers.

Skills

An individual should have the skills to apply basic mathematical principles and processes in everyday contexts at home and work (e.g. financial skills), and to follow and assess chains of arguments. An individual should be able to reason mathematically, understand mathematical proof and communicate in mathematical language, use appropriate aids including statistical data and graphs, and understand the mathematical aspects of digitalisation.

Attitudes

A positive attitude in mathematics is based on the respect for truth and a willingness to look for reasons and to assess their validity.

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Competence in science refers to the ability and willingness to explain the natural world by making use of the body of knowledge and methodology employed, including observation and experimentation, in order to identify questions and to draw evidence-based conclusions. Competences in technology and engineering are applications of that knowledge and methodology in response to perceived human wants or needs. Competence in science, technology and engineering involves an understanding of the changes caused by human activity and responsibility as an individual citizen.

Knowledge

For science, technology and engineering, essential knowledge comprises the basic principles of the natural world, fundamental scientific concepts, theories, principles and methods, technology and technological products and processes, as well as an understanding of the impact of science, technology, engineering and human activity in general on the natural world. These competences should enable individuals to better understand the advances, limitations and risks of scientific theories, applications and technology in societies at large (in relation to decision-making, values, moral questions, culture, etc.).

Skills

Skills include the understanding of science as a process for the investigation through specific methodologies, including observations and controlled experiments, the ability to use logical and rational thought to verify a hypothesis and the readiness to discard one's own convictions when they contradict new experimental findings. It includes the ability to use and handle technological tools and machines as well as scientific data to achieve a goal or to reach an evidence-based decision or conclusion. Individuals should also be able to recognise the essential features of scientific inquiry and have the ability to communicate the conclusions and reasoning that led to them.

Attitude

Competence includes an attitude of critical appreciation and curiosity, a concern for ethical issues and support for both safety and environmental sustainability, in particular as regards scientific and technological progress in relation to oneself, family, community, and global issues.

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Early Mathematical Foundations in Montessori environment (Ages 3-6)

In a Montessori kindergarten, mathematics begins long before a child encounters written symbols or formal lessons. It begins in the child's hands, eyes, and heart—in the rhythm of daily routines and the joy of discovery. For children aged three to six, learning mathematics is not an abstract exercise but a living experience woven into their play, movement, and exploration of the world.

At this stage, children are in what Maria Montessori called the *"absorbent mind"* phase. Their capacity to take in information effortlessly is extraordinary. They are particularly sensitive to language and precision, which allows them to learn mathematical vocabulary naturally and use it meaningfully. A child might proudly say, "I divided the beads into equal groups," long before they could write a division symbol. Through conversation, imitation, and joyful repetition, the language of mathematics becomes part of their everyday speech.

The Montessori classroom is carefully designed to nurture this process. Every material, from the smallest spindle box to the golden beads, invites the child to explore relationships between quantities. The materials are beautiful, precise, and self-correcting, guiding the child toward concentration and understanding. The golden bead material, for example, allows children to *see* and *feel* the difference between a unit, a ten, a hundred, and a thousand. They can hold numbers in their hands, carry them across the room, build them, and exchange them. By physically combining and separating beads, they experience addition, subtraction, multiplication, and division in a tangible, joyful way.

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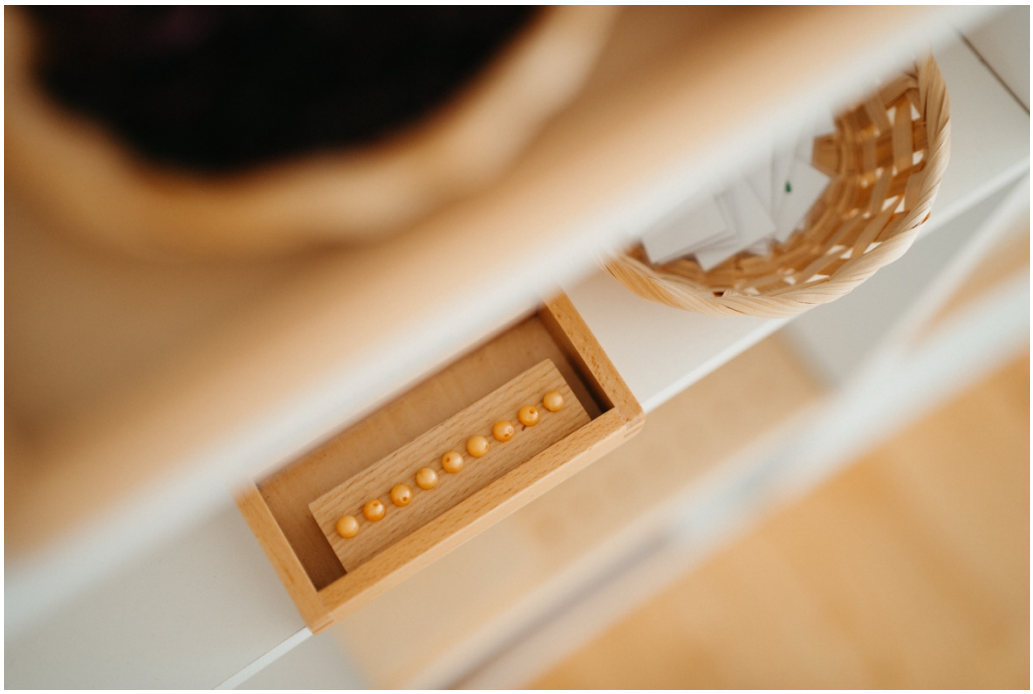
In this environment, abstract mathematical concepts are introduced gradually through concrete experience. The emphasis is always on *doing before thinking*, and *thinking before writing*. When a child counts apples for snack time or divides crayons among friends, they are not just learning to calculate—they are learning to reason, plan, and collaborate. Real-life situations such as setting the table, baking bread, or measuring seeds for planting provide endless opportunities for mathematical thinking.

Through these experiences, children begin to internalize key mathematical ideas: order, sequence, quantity, and pattern. The Montessori guide acts as a quiet observer, offering materials and language at just the right moment to match the child's curiosity. The result is a natural love of numbers—one that is grounded in reality, enriched by movement, and strengthened by success.

By the time Montessori children leave the kindergarten environment, they have developed not only a firm grasp of quantity and operation but also confidence in their own ability to solve problems. They see mathematics not as something separate from life, but as a way of understanding it. These early experiences form the roots of later scientific and numerical competence, nurturing a mindset of curiosity, logic, and joyful discovery that will guide them well into their elementary years and beyond.



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Building Mathematical Concepts in the Montessori Elementary Environment

The Montessori approach to mathematics focuses on supporting the **natural development of a child's mathematical sense**. This is achieved through a system of scientifically prepared materials that guide children from concrete experiences to abstract understanding.

In a Montessori Elementary classroom, mathematics begins not with memorization but with movement, touch, and discovery. Every material is designed with intention—crafted to make the invisible visible, the abstract concrete. When a child traces the golden beads with their fingers or arranges the fraction circles on a mat, they are not merely playing with objects; they are *thinking through their hands*. Each manipulation builds a bridge between the world they can see and the ideas they are beginning to understand.

These materials are not simply teaching aids—they are companions on the child's journey toward abstraction. A set of bead chains might first help a six-year-old count by twos or threes, but as time passes, that same material becomes the foundation for understanding multiplication, squares, and cubes. This evolution happens naturally, guided by curiosity and readiness rather than by adult instruction. The built-in control of error—so characteristic of Montessori design—allows children to notice and correct their own mistakes. There is no need for external judgment; the materials quietly guide reflection and self-correction, nurturing independence and confidence.

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This process reflects what Maria Montessori called *psychoarithmetic* and *psychogeometry*—ideas that see mathematical understanding as an organic part of human development. Children are not forced to “learn math”; they *unfold* it, step by step, through meaningful engagement with their environment. For every new level of comprehension, there is a material ready to meet the child’s need: from number rods to decimal boards, from geometry sticks to the binomial cube. Each tool represents a milestone in their growing capacity for abstract thought.

As the children progress, the physical materials gradually give way to pure reasoning. One day, they realize they no longer need the beads or the fraction circles—the concepts live within them now. This transformation, from the concrete to the abstract, is one of the most profound journeys in Montessori education. It mirrors the European Union’s vision of mathematical competence: not rote calculation, but deep understanding, problem-solving, and adaptability.

In this way, Montessori classrooms do more than teach math—they cultivate thinkers. The materials open a path where children joyfully experience how numbers, patterns, and relationships shape the world, preparing them to navigate both the tangible and the abstract with confidence and wonder.

Story from the classroom

Work of the hands help the mind to see

In the second year in the environment a group of students are gathered for follow up work. These students have been exploring multiplication through work with the checkerboard and practicing facts on the finger charts. They also have over the past several weeks explored concepts of addition and subtraction with the bead bars. They have arranged multiples, traded beads for larger quantities and even tested out the commutative law. This work has been valuable preparation leading to independent discoveries.

As a group the presentation begins with the teacher asking the student to lay out the red one bar once verbalizing “ one taken one time”, then taking the green two bar “ two taken one time” continuing with the three and four bar before asking the students to continue until reaching the golden ten bar. “What would it look like if we took one two times?” M an eager student takes

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two red one bars out two times. “What about two taken two times?” M eager to show what they know takes out two green two bars and places them on the mat below the two bar taken one time while D shouts out FOUR. As the guide we work and take the one’s column creating rows of one taken one time, two times, three times until we take one ten times.

“ We are just counting” observes one students, “we have one, two, three, four”

As the guide after this observation I asked the children to continue with each bead bar taking it out two, three, four times until they’ve completed the column or row. I did not ask the students to calculate as this lesson is for the process of multiplication and to offer each student a separate revelation.

About ten minutes later as I am working with another group of children I hear M exclaim “we are doing multiplication!” with a big smile across her face.

Bead by bead, row by row , they construct the multiplication table. The material guides them without adult intervention. The control of error is set by their understanding of numbers and concrete material in their hands.

When the table is completed another action is taken unprompted. D – who enjoys finding the answer goes to the bead cabinet and grabs the ten square and trades it for the ten, ten bars, prompting M to go and get the nine square, suddenly there is a flurry of activity exchanging independent bars for the square of three, the square of four. The work took almost half of the work cycle and proud of their work the student ask to leave their mat until after snack so others can admire their efforts. Through this work a web of relationships, geometric patterns, and understanding of the rules of multiplication were revealed through the work of their hands, allowing their minds to see.

Montessori akademija, Lithuania

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Connecting Math to the Real World

In the Montessori Elementary classroom, mathematics is never confined to a single shelf or a specific time of day. It flows naturally through the children's daily experiences, quietly linking their abstract discoveries to the tangible world around them. When children begin to see numbers, shapes, and measurements not as isolated facts but as tools for understanding life, mathematics becomes alive—relevant, joyful, and purposeful.

It often starts with a spark of curiosity. A group of children might decide to build a model of an ancient Roman city after their history lesson. Soon, math enters the picture: they calculate scale, convert measurements, and adjust proportions to make their model fit the classroom space. Others, preparing an experiment on plant growth, might create tables to record data, measure the height of seedlings each day, and

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compare averages. Each activity gently weaves mathematical reasoning into a broader fabric of exploration, creativity, and collaboration.

Practical applications extend beyond the classroom walls. When children plan a class trip to the science museum, they must read timetables, estimate travel time, and work within a budget. “If we take the 10:15 train, we’ll arrive just in time for the workshop,” one might say, while another checks how much each ticket costs and whether they can afford a snack afterward. These small, real-life decisions nurture mathematical competence in a way no worksheet could ever achieve. In Montessori education, this integration reflects a deep respect for the child’s developing sense of independence and responsibility. Mathematics becomes a trusted companion in their journey toward understanding the world. They begin to see how numbers support their ambitions—how ratios, geometry, and data serve their ideas rather than limit them.

This approach resonates strongly with the European Union’s vision of mathematical competence: using knowledge and reasoning to solve problems in diverse contexts. By engaging with mathematics through meaningful experiences, Montessori children are not only mastering skills—they are building the confidence and flexibility to apply them wherever life takes them. Mathematics, in this way, ceases to be an abstract subject and becomes a language for living and learning.

Story from the classroom

how our expedition to the historic town of Banská Štiavnica was born

It all began quite unexpectedly – while working on a project about volcanoes. As Albert and Martin were exploring different types of volcanoes, they mentioned Banská Štiavnica, a town known for its rich history and volcanic origins. Their curiosity was like a small spark that quickly turned into a desire to see everything in real life – not just in pictures or encyclopaedias.

And so the idea of an expedition was born. But before we could set off, the boys had to figure out the most important part: the preparation. And this was exactly the moment when we saw what incredible mathematical abilities children can develop when they plan a real and meaningful going out.

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Albert and Martin looked up transportation options, compared departure and arrival times, counted transfers, and estimated travel duration. They chose accommodation – comparing prices, capacity, distance from the centre, and availability. They calculated how much tickets, activities, and meals would cost.

Suddenly, mathematics was no longer a set of exercises in a notebook. It became a bridge they needed to turn their trip into reality.

In their planning, everything they already knew came into play – understanding time, working with timetables, basic operations, and estimation. And each step was guided by thoughtful questions: How much does it cost? How much do we need? What is the most efficient option? All of this happened under the supervision of the teachers, but with a strong emphasis on their independence, responsibility, and decision-making skills.

The expedition turned out wonderfully. We visited important landmarks, learned about remarkable personalities connected to Banská Štiavnica, and most importantly – the children experienced learning that was real, meaningful, and deeply connected to their own interests.

Jolly HOME SCHOOL, Slovakia

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Linking Learning with Reality at Every Age

From the very beginning of their educational journey, Montessori children learn that mathematics is not something that exists only in books—it lives all around them. A three-year-old might count how many apples are needed for snack time or notice how many are left after sharing with friends. Numbers come alive through daily actions, and quantity takes on meaning through purpose. The same happens when children tend to their classroom garden, measuring soil, watering plants, and keeping track of growth. Even the simple act of maintaining a daily calendar—recording the date, the weather, and the season—anchors mathematical understanding in real life.

As children move into the Elementary years, this connection between learning and life deepens. The Montessori classroom for ages 6 to 12 offers what Maria Montessori called a “dual environment”: one that exists both within the classroom and out in the world. Inside, the materials and lessons give children the keys to explore mathematical, scientific, and social concepts. But the true magic happens when they take that knowledge beyond the classroom walls.

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It is not unusual to see a group of children setting out for a small adventure—perhaps a trip to the local market to buy ingredients for a shared meal. What seems like a simple outing is actually a lesson rich with learning: they plan a budget, calculate prices, compare options, and ensure their purchases stay within the limits of what they can afford. Along the way, they navigate streets using maps, read signs, and even make choices based on nutritional information. Mathematics here is not abstract—it is lived, tested, and enjoyed.

This freedom to explore and apply learning in real contexts nurtures a deep sense of competence and independence. The child begins to see themselves not as a passive learner, but as a capable member of society. They learn that knowledge carries responsibility and that mathematics, logic, and organization are essential tools for contributing to their community.

Within the classroom, mixed-age groupings enhance this experience further. A younger child might observe an older peer calculating the cost of materials for a group project, while an older student learns patience, leadership, and empathy through guiding others. These interactions naturally cultivate cooperation, moral awareness, and a sense of belonging—values that mathematics alone cannot teach, but which it quietly supports through structure and clarity.

In every stage of development, Montessori education ensures that mathematics remains grounded in reality. Whether it’s through counting apples, tracking the seasons, or managing a real-world budget, children learn that numbers are not just symbols—they are the language through which we understand, care for, and engage with the world.

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Story from the classroom

Math is everywhere

In our classroom, mathematics often begins in the most unexpected ways. One of the children's favourite projects is baking a treat for their classmates – a simple, joyful activity that naturally turns into a rich mathematical adventure.

Throughout the year, there is always a moment when someone calls out: "Let's bake!" And from that moment, the classroom transforms into a small planning studio. First, the children create a shopping list: flour, eggs, sugar… Then comes the real challenge – turning this list into a budget.

At the shop, they compare prices, check which brand offers more for less, and figure out how many packs they actually need. They add up the totals, subtract what we already have in the classroom, and make decisions: "If we buy the cheaper cocoa, we can afford strawberries too." The goal is simple: stay within budget and still bake something delicious. With older children, the mathematical thinking becomes even more sophisticated. They calculate discounts, estimate cost per unit, and evaluate which option truly is the best deal. Suddenly, percentage calculations and ratios are not abstract – they become essential tools for real-life decision-making.

Throughout the whole process, something beautiful happens. The children are not only strengthening number sense and financial literacy; they are planning, negotiating, problem-solving, and collaborating. And when the shopping is done and the ingredients are laid out on the table, they finally get to bake – measuring, counting, pouring, and adjusting the recipe as needed.

But the most special moment comes at the very end, when they share what they baked.
Because the exchange of money is not just about buying things.
It is about creating joy – making someone else, or even myself, happy.

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Building Mathematical and Scientific Thinking through Hands-On Exploration

In the Montessori Elementary classroom, mathematics and science are not separate subjects—they are ways of understanding the world. Children are natural experimenters and problem-solvers. They don't just study facts; they *live* them through projects that unite numbers, observation, imagination, and cooperation.

One day, a group of children might decide to recreate the Solar System in the hallway. Together, they calculate scale ratios, measure distances, and plan their model's layout. Soon, they're working with decimals, proportions, and geometry—but they are also budgeting for materials, writing labels, and preparing a presentation. What begins as a "math project" unfolds into a complete experience of scientific modelling, teamwork, and communication.

In another corner, children might spend the night at school to observe and record temperature changes over 24 hours. With thermometers, tables, and notebooks, they connect their data to the rotation of the Earth, discovering patterns of heat and light. The classroom becomes a laboratory of real phenomena, where curiosity drives the process.

Montessori educators can intentionally weave such projects into their lessons. The key is integration—connecting math and science to real contexts and allowing the child to take ownership of discovery. The guide's role is to offer tools, structure, and gentle direction, while the children themselves construct meaning.

By engaging in these kinds of *Great Works*, children develop not only mathematical accuracy but also scientific reasoning and planning abilities. They learn to hypothesize, test, measure, adjust, and communicate results—skills that are at the heart of both STEM competence and the Montessori vision of education for life.

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History, Discovery, and the Art of Inquiry

Children are naturally fascinated by how things came to be—how people learned to measure time, why tools evolved, and who first discovered the secrets of nature. Montessori guides can build on this innate curiosity through storytelling and historical context, transforming abstract lessons into meaningful journeys of discovery.

Imagine beginning a math lesson not with numbers but with a story: ancient people measuring their fields with footsteps, or sailors using the stars to navigate. These stories of human invention show that measurement, calculation, and problem-solving grew from real human needs. From there, children can explore hands-on: measuring their classroom using hand spans, comparing results, and inventing their own "standard units" before discovering why shared systems like meters and seconds became essential.

The same spirit of exploration guides the study of biology and geography. The "Who Am I?" Animal Game, for instance, invites students to think like scientists—asking questions, sorting data, identifying relationships. They begin to see patterns and organize knowledge, developing the early habits of analytical thinking.

Through such integrated lessons, the classroom becomes a place where history, science, and art flow together. The story of the pencil leads to experiments with graphite and kaolin. The making of iron gall ink connects botany, chemistry, and language as students collect oak galls, mix solutions, and write poems with their homemade ink. Every activity is a small echo of human curiosity—of how civilization itself advanced through observation, invention, and creativity.

In this way, the Montessori guide acts as both storyteller and scientist, offering a narrative that gives children context, purpose, and wonder. Learning becomes not an obligation but a discovery of humankind's shared intellectual heritage.

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Story from the classroom

Mathematical thinking in Afternoon Tea Party

One of the most special moments in our school is our Afternoon Tea Party – gentle gatherings where children become the teachers and parents become their curious learners.

As families sit down with tea and biscuits, children proudly take their parents by the hand: "Come, I want to show you something!"

Parents are often drawn straight to the mathematics shelves – the golden beads, fraction circles, bead chains. What feels mysterious to adults feels wonderfully clear to the children.

And then the real teaching begins.
"Look, this is how I exchange ten units for one ten."
"See? A thousand is just a cube of tens."
"Let me show you how I think about this problem…"

They don't just demonstrate the steps — they reveal their mathematical thinking. Parents suddenly see that mathematics is not only counting or measuring but explaining why something works.

You can see admiration in the parents' eyes, and pride in the children's voices.
For a moment, the classroom feels transformed: calm, joyful, and full of understanding.

By the end of the tea, everyone leaves closer than they arrived — parents inspired, children empowered, and mathematics shining as something meaningful, human, and shared.

Jolly HOME SCHOOL, Slovakia

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The Montessori Path to Engineering and Numeric Mastery

Mathematical understanding in Montessori grows like a tree—from solid roots in concrete experience to the branching abstraction of reasoning. Children begin by handling bead chains, wooden hierarchies, and felt squares, slowly internalizing the patterns and relationships that define number systems.

Working with the Wooden Hierarchical Material, they see numbers as living quantities, each order—units, tens, hundreds, thousands—embodied in wood and color. They explore how these values relate, laying the foundation for advanced tools like the Large Bead Frame. Similarly, through the Multiplication of Orders with felt squares, children grasp the structure of the decimal system, visualizing how tens multiplied by tens create hundreds, and tenths multiplied by tenths create hundredths.

Engineering thinking naturally emerges through this kind of reasoning. When students measure the circumference of a circle, they discover geometry as both an art and a science. Soon, they are creating posters that compare diameters and circumferences, calculating π, and connecting these discoveries to art and design.

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Scientific experiments deepen this connection. In “The Plant Needs Minerals” study, children act as researchers—controlling variables, recording data in their work diaries, and drawing conclusions about what sustains life. Similarly, geography command cards and the “Work of Air and Water” experiments invite observation, hypothesis-making, and field study, blending geography, physics, and environmental science.

Through daily reflection in work diaries, children document not just what they did but *how* they thought. These journals help them plan, observe, and evaluate—core skills in both science and engineering processes.

Each activity, from drawing lines inspired by Kandinsky to studying sediment at a riverbank, helps children recognize the unity of all knowledge. Numbers, forces, and forms are no longer separate domains—they are expressions of the same cosmic order. In this living curriculum, the seeds of numeric precision, scientific method, and engineering imagination grow side by side, preparing the child not just for further study but for a lifetime of curiosity and purposeful creation.

Engineering is an inseparable part of Montessori Cosmic Education. Students aged 6–12 learn through projects, experiments, and practical demonstrations, which allows them to better understand and apply acquired knowledge in the real world.

In Montessori Cosmic Education, students do not learn specific information by heart. They receive key presentations that provide essential information, which they then process in their own ways into versatile, innovative, and self-directed projects. They gradually connect new knowledge with previous knowledge and find their own new challenges and ideas for solving them. Working on their own projects develops logical

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thinking, problem-solving abilities, and, last but not least, they learn what it means to collaborate and how to do it.

The knowledge a student gains in the classroom is linked to real life, and after integrating new information, the student always seeks to discover and explore that knowledge in the real world around them. They look for ways to use new knowledge in the real world and have an unlimited field for creativity and support for their real-life projects or the production of various kinds of models.

Model making is an inherent part primarily of Geography (models of mountain ranges, countries, various types of erosion, the Solar System), Biology (cell models, models of muscle function), but also History, if we recall that history in Montessori is the history of inventions—students explore all human inventions from the hand axe to the latest technologies, and for every invention, they are offered the opportunity to make or at least examine and understand its model.

Students in the Montessori Elementary cycle (six years) progressively move through the entire history of human inventions, thus facing the challenges that human beings have solved since they first appeared on Earth. Children study the stories of inventors and thus become inventors themselves. The human being is introduced to children as an “Engineer”—a skillful, intelligent, and kind creator of this world. And from this moment on, children are comprehensively guided to become such human beings themselves.

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Practical tips and suggestions developing the competence

Developing numerical, scientific, and engineering skills in children is not about memorizing facts—it's about nurturing curiosity, reasoning, and a love for discovery. In Montessori education, these skills grow naturally when children are invited to explore the real world through meaningful experiences, both at school and at home. Below are practical ideas and examples that help bring this vision to life.

At School: Cultivating Curiosity and Understanding

- **When introducing each new topic, tell children a real story from history.** Stories awaken imagination and connect abstract knowledge to human experience. A lesson about geometry can begin with the story of ancient Egyptian land surveyors who measured fields after the Nile floods—showing how geometry emerged from practical need. When introducing the decimal system, teachers might tell the story of how humans learned to count and trade, moving from pebbles and knots to written numerals. These stories help children see that mathematics, science, and engineering evolved from human curiosity and creativity.
- **Provide children with relevant information from the first day of school.** Children do not need to wait until upper grades to explore scientific or mathematical ideas. Even six-year-olds can be introduced to the *laws of nature* through simple experiments and vivid presentations. For example, a lower elementary group can observe evaporation by leaving a dish of water on the windowsill or can trace the "journey of a drop of water" through the Great River Story. The goal is not to master complex theory but to spark awareness and excitement that grows deeper each year.
- **Give children overviews and keys to unlock the world.** Instead of overwhelming children with isolated details, offer them the "big picture." Montessori Great Lessons—such as *The Coming of the Universe*, *The Story of Numbers*, and *The Story of Writing*—serve as keys that open vast fields

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of knowledge. After hearing the Story of Numbers, for example, children might choose to explore Roman numerals, number systems from different cultures, or the invention of zero. The overview inspires independent exploration; each child's curiosity becomes the engine of deeper learning.

- **Connect lessons to real, hands-on projects.**
  Let children apply what they learn through projects that combine math, science, and creativity. Building a model bridge introduces measurement, weight distribution, and simple mechanics. Growing plants connects botany and arithmetic as they measure height, count leaves, and record data in charts. By linking knowledge to purposeful activity, abstract concepts become living realities.

At Home: Bringing Learning into Everyday Life

- **Observe the world around you and talk to children about what you see.**
  A simple walk becomes a science lesson when you notice the shape of leaves, the patterns of clouds, or the way shadows move. Ask questions like, "Why do some trees lose their leaves while others don't?" or "How does the angle of the sun change our shadow?" Encourage children to wonder, to think, and to find explanations through books or experiments.
- **Try to impress children with reality.**
  Show children the awe and beauty of the real world—how a bridge stands, how rainbows form, how seeds grow. Take time to explore museums, farms, construction sites, or nature trails. Real experiences make abstract knowledge meaningful. A visit to a planetarium, for instance, can transform a lesson about the solar system into a lifelong fascination with astronomy.
- **Use professional terms naturally.**
  Children love precise language. When cooking together, say "We're measuring 200 milliliters of milk" or "This structure is symmetrical." Using correct terminology—temperature, density, balance, volume—builds familiarity and confidence with scientific and mathematical language.

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- **Plan shopping trips together.**
  Let children help create the family shopping list, compare prices, calculate totals, and decide how to stay within budget. Older children can calculate discounts, estimate cost per unit, and evaluate the best deals. These real-life experiences develop number sense and financial literacy effortlessly.
- **Plan vacations and trips collaboratively.**
  Invite children to study maps, calculate distances, and plan routes. Discuss time zones, currency exchange, or the science of flight. Create a trip budget together, assigning roles: one child tracks expenses, another calculates total travel time. These tasks combine geography, mathematics, and responsibility in a fun, practical way.
- **Involve children in household planning.**
  Turn everyday routines into opportunities for reasoning and organization. Make charts for cleaning schedules, meal planning, or family projects. If you're cooking together, discuss proportions: "If the recipe serves four, how much do we need for six people?" Measuring, timing, and planning together strengthen both math and life skills.
- **Create shared collections and visual records.**
  Encourage children to collect and classify real-world items—leaves, rocks, shells, or even bottle caps. Label and organize them by type, size, or location. Make maps of places visited or plan future destinations, adding facts about their geography or culture. These tangible experiences train observation, categorization, and critical thinking—the same mental habits that underlie scientific inquiry.

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How Mathematical competence and competence in science, technology and engineering is visible in the Montessori Elementary classroom?	
Essential knowledge (students need to know about)	
Numbers, measures and structures	Children work with mathematical materials such as the bead chains, fraction insets, and geometric solids to explore relationships between quantities, patterns, and structures. They use real measurements in projects—measuring distances on maps, calculating scale for models, or recording temperature and time during experiments.
Basic operations and basic mathematical presentations	Operations—addition, subtraction, multiplication, and division—are learned through concrete manipulation using the golden bead material, stamp game, bead frames, and other Montessori Math materials. These activities progress from concrete to abstract, ensuring deep conceptual understanding.
Mathematical terms and concepts	Mathematical language is introduced naturally and precisely. Children use correct terminology in context—speaking about “squares,” “thousands,” “multiples,” or “equilateral triangles”—and learn to connect symbols with meaning through conversation, storytelling, and exploration.
An awareness of the questions to which mathematics can offer answers	Through real-life projects, such as budgeting for a trip, tracking plant growth, or designing a map, children discover that mathematics answers practical and theoretical questions. They see that math helps to solve problems, explain patterns, and support decision-making.
Basic principles of the natural world	Geography, biology, chemistry, and physics lessons begin with “Great Stories” that present the formation of the universe, the coming of life, and the interdependence of systems. Experiments on air, water, and plants allow children to discover physical laws through observation.

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Fundamental scientific concepts, theories, principles and methods	Scientific understanding develops through hands-on experimentation—studying states of matter, photosynthesis, erosion, and simple mechanics. Children use the scientific method intuitively: asking questions, hypothesizing, experimenting, and observing outcomes.
Science as a process for the investigation of nature	Science is not presented as memorization of facts but as a living process. Children investigate nature through experiments such as *The Work of Air* or *The River*, record data, compare results, and derive natural laws. They keep journals documenting findings and reflections.
Technology and technological products and processes	Children explore simple machines, tools, and building processes through engineering-based tasks—constructing bridges, testing materials, or creating models. They use technology appropriately for research, data recording, and presentation, guided by safety and purpose.
The impact of science, technology, engineering and human activity in general on the natural world	Presentations on ecology, ecosystems, sustainability, and human innovation help children understand how human actions shape the environment. Projects such as energy studies, recycling, and exploring local ecosystems cultivate responsibility toward nature and society.
Core skills (students should be able to)	
Apply basic mathematical principles and processes in everyday contexts at home and work, including financial skills	Students use math for real purposes—planning class trips, shopping for needs of the classroom, dividing group work fairly, or managing classroom budgets. Financial literacy is introduced naturally through these experiences.
Follow and assess chains of arguments	Through mathematical problem-solving, geometry proofs, and science experiments, children learn to follow logical steps and assess reasoning. They discuss results collectively, comparing hypotheses and outcomes.
To reason mathematically	Montessori materials such as the Bead Frames and Geometry Cabinet encourage reasoning about quantity, shape, and proportion. Children explain their thought processes verbally, strengthening analytical skills.

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Understand mathematical proof	While formal proofs come later, children build the foundation by discovering consistent relationships—such as the formula for a triangle's area or the constant ratio of a circle's circumference to its diameter—through direct exploration and repetition.
Communicate in mathematical language	Children present their findings using correct terminology, written equations, charts, and drawings. They discuss their reasoning with peers and guides, often using visual aids like graphs or geometric figures.
Use appropriate aids, including statistical data and graphs	In projects like recording weather patterns or plant growth, children collect, organize, and represent data through charts and graphs. This visual representation reinforces analytical thinking.
Use and handle technological tools and machines	Students learn to use simple tools—compasses, balances, magnifiers, and microscopes—and gradually integrate digital technologies for research and presentations, always in a purposeful, hands-on way.
Investigate nature through controlled experiments	Experiments such as *Plant Needs Minerals* or *The Work of Air* teach children to set up fair tests, control variables, and record data carefully. They learn to predict, observe, and conclude systematically.
Use and handle scientific data to achieve a goal or to reach an evidence-based decision or conclusion	Students design small-scale research projects—e.g., testing materials for strength in a bridge model or comparing soil types for planting—and base conclusions on collected evidence.
Be able to recognise the essential features of scientific inquiry	Through repeated experimentation and journaling, children understand that inquiry involves asking questions, testing, observing, and drawing conclusions. They come to see science as a process of discovery rather than a set of answers.
Attitudes (students value)	
The respect for truth	Montessori culture emphasizes accuracy and honesty in observation. Children learn that data and results must reflect what they actually saw, not what they hoped to find.
The willingness to look for reasons	Curiosity drives learning: children constantly ask "why" and "how." Guides nurture this by redirecting questions toward discovery and independent reasoning.

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The willingness to assess validity of reasons	Through peer collaboration, children learn to evaluate each other's reasoning—checking calculations, comparing results, and refining ideas through respectful discussion.
Critical appreciation and curiosity	The Montessori environment sustains curiosity through freedom of choice, hands-on materials, and real-world connections. Children learn to appreciate complexity and beauty in both math and science.
Interest in ethical issues and respect for both safety and sustainability, in particular as regards scientific and technological progress in relation to oneself, family, community and global issues	Through cosmic education, children understand the interdependence of life and the impact of human activity. They learn about responsible innovation, conservation, and the ethical use of resources, linking science to moral and ecological awareness.

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