

Guidelines for STEM activities at pre-school level

New methods for teaching STEM to young children

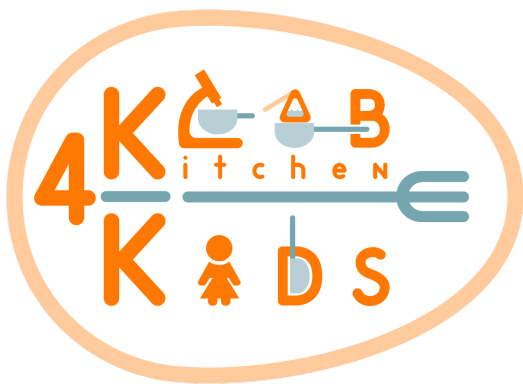




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New methods for teaching STEM to young children



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1. What is STEM?

The acronym STEM refers to 4 pillars of modern education: science, technology, engineering and mathematics, understood as follows:

Science: various areas of natural sciences, including systemic studies of nature and functioning of materials and the physical world (the universe), based on positivist and quantitative methods such as: observation, experiment or measurement, aimed at formulating the regularities that describe the analysed facts in a general manner. The term refers to biology, physics, chemistry, geology, and other sciences related to studying Earth;

Technology: the field of science which refers to inventing and using technological tools, as well as studying their relations with life, society and the environment. This area of science is based on industrial art, engineering and applied sciences. Although most frequently mistaken for modern technologies, IT or robotics, T in the STEM acronym refers to each use of tools in order to improve the human environment or solve everyday problems (not only the use of modern technologies, but also tools such as a screwdriver, drill, hammer, mixer, knife, waffle iron, etc.);

Engineering: an art of practical, useful application of knowledge driven from biology, physics and chemistry in order to design and construct various devices, such as: engines, machines, bridges, buildings, vehicles, vessels, etc. This area is the most poorly recognised in pedagogy, often treated as something inaccessible or even unnecessary to a young child;

Mathematics: a group of interconnected areas of knowledge including algebra, geometry and arithmetic, focused on investigating the notion of a number, quantity, shape, space, dimensions and their mutual relations described through specialist terms/mathematical concepts.

2. Why STEM in preschool? Why is STEM education important at preschool?

STEM education is based on five key components:

- Integration
- The practical dimension of knowledge
- Developmental thinking
- Co-operation
- Love of learning

Integration

Rather than teaching the disciplines of knowledge as independent, isolated subject sets, STEM activities are project based workshops, using inquiry-based approach with a strong emphasis on interdisciplinary learning.

Taking an example of an architect, in order for them to develop their project it is necessary to use different aspects of knowledge: not only mathematics, but also engineering, technology, broadly understood science or even artistic inspirations. All the elements necessary to complete the task are not separate from each other but need to be interlinked into practice, intertwined in a practical and seamless way, enabling the architect to design complex buildings.

The practical dimension of knowledge

STEM is adapted to the way we work and to solve everyday problems.

It is a unique approach to teaching and learning offering practical applications of knowledge; showing its immediate usefulness in human life.

Look at the child building a cardboard bridge. How many questions does he/she has to answer, how many problems he/she has to solve in order to create a durable structure. What cardboard should I use? How to assemble it? What shape could I design? How can I make the bridge bear the weight? etc. Such plays and activities allow the child to understand the world better.

Development of scientific thinking

STEM education is based on solving complex, meaningful problems that require the ability to perceive, analyze, hypothesize and verify predictions, observe and collect data, draw conclusions. All the above-mentioned elements constitute the core of scientific thinking, which requires logic and precision in formulating judgments related to the observed phenomena

STEM education also fosters the development of creative thinking. When a child faces a challenge (such as build the highest possible tower using only toothpicks and jelly beans) or an open problem which does not have a clear, one-sided answer, he/she gets the chance to exercise the flexibility of thinking. In such activities, one has to throw away the stereotypes and well-known schemas of thinking, and allow oneself a moment of "freedom", creativity, researching for new solutions by trial and error.

Co-operation

STEM education promotes teamwork and communication skills. Important components of teamwork are: assuming the role of a leader and subordinate, selecting and sharing tasks, as well as taking responsibility for their implementation. During such activities children learn to communicate, explain their own ideas, share different perspectives of seeing the problem and negotiate the solutions. Take a look at children carrying out the group project. Each of them is different, with a slightly different approach to solving problems. Yet together, by motivating and supporting each other, they are able to work out an innovative solution. None of these children would achieve such results by working alone.

Love of learning

In the modern world continuous development and learning are essential to personal and professional success. Therefore, students should leave the school system with a passion for learning. If this does not happen, and children do not want to learn and gain new skills, they will constantly struggle with their work and life. In this context, the education immersed in the STEM approach is vitally important. The greatest gift we can give to children at an early age is cognitive curiosity, self-efficacy and self-confidence, thirst for knowledge and passion for development. Thanks to such abilities, children will be prepared to meet the challenges of both higher education and the modern world. No matter where their life journey takes them.

3. Why kitchen as STEM laboratory?

A preschool kitchen, perfectly equipped with various utensils, devices and ingredients can be a unique kind of scientific laboratory, used to conduct workshops and scientific experiments, induce chemical reactions and observe their course and results. We are dealing here with the idea of cooking as a scientific process that integrates in a natural way the elements of biological, chemical and physical knowledge with the values of a healthy, ecological and sustainable cuisine. Playing with cooking can support preschool children in sensual exploration and building the understanding of the world around. Participating in such activities will allow children to develop their culinary interests, but also will support their creativity, planning abilities, independence and manual dexterity. The acquired abilities can be transferred to other educational challenges and/ or everyday life.

4. What are the core STEM skills?

As a part of STEM-based education, skills related to creative and critical thinking are developed along with building scientific knowledge through the ability to discover, analyze and solve everyday problems (divergent thinking).

Core STEM skills:	Other skills:
Learning to think and discover <ul style="list-style-type: none">Creative thinking<ul style="list-style-type: none">Fluency of thinkingFlexibility of thinkingOriginality of thinkingSensitivity to problemsElaborationCritical thinking	Learn to move gracefully <ul style="list-style-type: none">Large and fine motor skillsHand-eye coordinationPrecise and efficient movement
Mathematical reasoning <ul style="list-style-type: none">Scientific thinking<ul style="list-style-type: none">Asking questionsAnalyzing and solving problemsDesigning experimentsConducting research - predicting, testing hypothesis, observing, experimentingDrawing conclusions based on evidence, reasoningUsing digital tools do conduct and document research	Learn to work in a team <ul style="list-style-type: none">Taking common decisionsSharing ideas: negotiating meaningsSharing responsibility for a taskAccepting leadership and managementFollowing the safety rules and discipline
	Learn to use language <ul style="list-style-type: none">Basic literacy: reading, writing, listening with comprehensionICT literacy: using computer to communicate with others

http://kitchenlab4kids.eu/?page_id=1622/#intro-4

While conducting hands-on experiments children acquire the ability to design their activities, investigate and conduct research, including predicting, formulating and testing hypotheses, and drawing conclusions based on the empirical data. While describing and processing numerical data, they practice mathematical thinking and using the ICT tools. Scientific workshops also foster the development of teamwork skills in children, negotiating decisions, sharing ideas and responsibilities. At the same time, they acquire the necessary

language competences and practice eye-hand coordination. A very important element of STEM education is teaching children how to learn, building internal motivation to learn science, strengthening a sense of agency and a positive self-image of oneself as a learner.

5. What are the STEM activities?

STEM might be implemented with the use of different methods and types of activities.

- We can invite children to participate in a classic scientific experiment (such as: <http://kitchenlab4kids.eu/?p=2075>)
- encourage them to take up the challenge (like this: <http://kitchenlab4kids.eu/?p=2082>)
- persuade them to build the constructions from edible materials/ food ingredients (like this: <http://kitchenlab4kids.eu/?p=2082>)
- or inspire them to patiently observe interesting phenomena (such as: <http://kitchenlab4kids.eu/?p=2640>).

All this combined with cooking, baking, tasting and testing together!

6. How to run the experiment/ hands-on experience?

Leonardo da Vinci said: "Wisdom is the daughter of experience". A. Einstein believed that the first lessons should contain nothing other than what is experimental and interesting to see. A nice experiment in itself is more valuable than twenty patterns drawn from our minds.

Each experience can be carried out according to the following stages:

Step 1: Building problem situation

Step 2: Formulating hypotheses

Step 3: Conducting the experiment

Step 4: Presenting the results, reasoning

Step 5: Summarizing

Step 1: Building problem situation

Present an issue that will be the subject of children's exploratory activities in a way that will arouse their interest, intrigue and inspire them to think. Formulate appropriate questions, the so-called research

problems. Remember, however, that they should not suggest the outcome nor the solution of the experiment, neither being too complex, nor too trivial. If the children are fully able to answer the posed questions before running the experiment, the situation will not motivate them to act.

Step 2: Formulating hypotheses

Hypotheses are children's answers to the research questions. Based on their own experiences and commonsense knowledge, children come up with ideas and assumptions about solving problems that can very often be intuitive, i.e. not supported by any arguments. Once all the children have submitted their suggestions, the next step is to validate them - and run the experiment.

Step 3: Conducting the experiment

The best form of conducting the experience is children's independent activity under teacher's control. Following the teacher's instruction, children perform specific activities, and you watch over their safety, if necessary, provide additional guidelines, help those children who expect and ask for help, organize a rotation of members' functions in a particular team if the experience is performed several times.

Step 4: Presenting the results, reasoning

The realization of the experience naturally draws our attention to its end result. Children, after carrying out research activities, share their results, discuss and compare whether they all obtained the same effects, whether there are differences between teams, and if so, to what extent.

The next phase of exploratory activities is inferencing, drawing conclusions. Children, preferably on their own, should summarize their activities, provide answers to previously posed research questions, and verify hypotheses. Teachers should direct the children's statements in such a way that they can explain problems through independent thinking and, moreover, they can present appropriate arguments - justifying their statements.

Step 5: Summarizing

The summary of the experiment can take various forms: a drawing, a diagram, answering the questions asked, creating a story, a poster, a short description or a letter to a friend etc. Especially non-standard speech-based suggestions can contribute to stimulating the child's language, developing the scientific vocabulary and concepts, and preparing the children to public speaking.

Understanding the experience observed by children can become an impulse to design other experiments, activities or tasks. Children intrigued by sensual activity may come up with new ideas/ experiments/ ingredients etc. that, in turn, will provide the backgrounds for further exploratory activities.

7. What are STEM challenges?

STEM challenge - is a unique method based on solving complex, interdisciplinary, real-life and open problems for which there is no 1 „proper” or „correct” answer, nor „ready to use” and “well practiced” scheme/ routine of acting. Contrary to experiments or experiences, STEM Challenge:

- does not include the precise activity instruction to follow - explains only the objective and criteria which need to be fulfilled by the solution;
- Often imposes important constraints for action, such as: the number of available materials or tools, or the time allocated to the task;
- requires the participants to be flexible and original in their thinking - not allowing reference to ready-made answers or action patterns;
- requires to use design thinking - to imagine and build a prototype of a device/ building/ construction, and to verify its effectiveness, i.e. to check whether the prototype meets the criteria specified in the task;
- introduces elements of competition and fun - a non-standard task structure which does not include the answer to the questions: „How should/ could we do it?” intrigues, interests, enlivens and brings a lot of positive emotions accompanying play. It results in plenty of different, original solutions - each answer/ design is unique!
- And more importantly, it brings joy to learning!

STEM Challenge usually includes the following stages of activities:

1. Planning - designing a solution, e.g. in the form of a drawing;
2. Building a prototype - with the use of available materials and tools;
3. Presenting solutions by children - comparing and testing prototypes;
4. Documenting and reflecting - children should describe their experiences in any form they choose, take photos, reflect on their solution and its effectiveness;
5. Summarizing discussion - What have we learned? What turned out to be the most difficult and why? What was the most funny?

6. Resting (time for incubation?) - give the children time to further investigation, reading, searching for other solutions, maybe repeating the challenge at home with siblings/ parents?
7. Repetition - a new, similar challenge (the same purpose, different materials, or same materials - different purpose or constrains - use your imagination)

8. How to prepare for a good STEM activity? /What you should remember about when planning STEM activities/ workshops?

When designing / preparing a STEM workshop, you should pay attention to the following components:

- Activities - choose verified and well documented projects or experiments
- Preparation - good preparation is the key to success
- Tools - consider the utensils and materials available
- Group - use the strengths of a team
- Project - provide children with follow-up activities or the possibilities of further exploration
- Purpose - focus on real purpose - learning by playing

Activities - choose verified and well documented projects or experiments

If you are a beginner just starting your adventure with STEM, then you need projects that have specific, well described results. Thanks to this, you will be able to predict where children may encounter difficulties, at what stage. For example, making a glowing insect requires some wiring preparation - which you might want to do yourself, especially if you're working with younger children. With well-checked activities you have a detailed activity scenario that allows you to see what activities can be frustrating, difficult or even not available for kids. Such a prior thoughtful planning allows you to properly prepare and, in a sense, avoid trouble.

Preparation - good preparation is the key to success

To be successful in STEM education, you need to understand very well the project/ experiments or activity offered to children. Before the workshop, you should carry out the project yourself. Thanks to this, you may discover that with the available resources or due to the lack of time, some components of the scenario would be easiest to prepare in advance. Or maybe you can demonstrate some of them in the form of a presentation?

Tools - consider the utensils and materials available

Sometimes the activities can be simplified or made more difficult by changing the tools used. Maybe in the case of older children it is better not to say what tools and materials they need? Your activity may be limited to delivering them simply. Allow the children to freely use a variety of tools, whatever they see necessary or appropriate to complete the project. Thanks to trials and errors, they will independently discover what needs to be done, what equipment should be used and what sequence of activities should be followed.

Group - use the strengths of a team

Use teamwork. You can allow the children to divide themselves into groups as desired. You can also allocate children to groups knowing their strengths and weaknesses. Remember about good cooperation and atmosphere in the team. Even if some preschoolers are unable to complete certain activities, don't worry. They will learn over time by observing their peers. And learning the power of cooperation is a fantastic life skill.

Project - provide children with follow-up activities or the possibilities of further exploration

As children are fascinated by an idea or concept, encourage them to keep learning, exploring, and creating. Although passion is usually strong, keep it stronger by providing the right information and materials to keep emotions alive. In this way, children's creativity and willingness to explore the world are born. This situation can be created by allowing children to pursue new projects, encouraging tinkering, or providing new ideas and resources to keep them exploring the topic with new activities.

Purpose - focus on real purpose - learning by playing

Your projects don't have to be perfect. You probably will encounter stumbles, mishaps and breakdowns. However, the ultimate goal of STEM is to develop skills - critical thinking, inquiry, creativity and collaboration. Even if you don't get the perfect end product, your STEM activity is still successful! You have just delivered an vitally important hands-on experience to children. Remember that you can always return to the proposed activity at a different time and try again. All great innovators know the power of trying again and learning from failures and mistakes.

9. What is a Learning Pathway?

Learning pathway is a sequence of resources that are grouped and logically ordered to allow children to master a particular topic, scientific concept or skill/competence. It is designed as a route for a learner to progress from preconceptions and commonsense knowledge to scientific reasoning. Learning Pathways were designed as a flexible tool for teachers to perceive STEM education as a long term process rather than a single, isolated event.

10. Why Learning Pathways instead of a single experiment?

Young children's learning should be perceived as a long-term process based on regular repetition of the same or similar experiences. Such recurrence enables the formation of certain patterns of thinking and schemas of acting in children's minds. The Learning Pathway also provides the possibility of cognitive transfer, i.e. transferring the knowledge and skills acquired in one learning situation to another, applying them in the course of another experiment, and using them in a different task or setting. Thanks to this, the child notices the usefulness of the acquired knowledge, has the opportunity to verify it, consolidate it and deepen/ strengthen in action. He can pursue the topic gradually, discovering new fields of exploration, new concepts, new areas of experience.

11. What types of Learning Pathways are designed in our project?

There are four types of pathways:

- A. Thematic pathways (based on a particular topic - ingredients/ types of food etc.)
- B. Pathways based on skills/ abilities expected learning outcomes
- C. Pathways based of STEM disciplines (Science, Technology, Engineering and Mathematics)
- D. Pathways based on scientific concepts (osmosis, state of matter, density etc.)

12. How to use the project website?

We invite you to the Kitchen as a STEM laboratory. You can use it in several ways: in KLab4Kids you will find basic information about STEM education and the possibilities of using simple materials and tools for its implementation. Most of all, however, you will find here tips on how to conduct STEM education in a preschool and at home in a way interesting for both children and adults. You can use ready-made scenarios

for STEM workshops in four languages. You can also use ideas for entire learning pathways that include activities linked by a common denominator. If you like our proposals, you can join the KLab4Kids as its co-creator - commenting on our proposals and creating your own ideas - activities and educational pathways. Enjoy your STEM!

13. How to design your own Learning Pathway?

- A. Use a search engine and find a keyword you are interested in (scientific concept, skill, food ingredient, phenomenon, process etc.)
- B. Search for the resources on the project website:
http://kitchenlab4kids.eu/?page_id=951#TeachingSetSelectLanguages
- C. Choose the resources you think are related with the keyword and might fulfill your expectations
- D. Design your own Learning Pathway using the following link:
https://docs.google.com/forms/d/e/1FAIpQLSefQr6-74HfWw7xP5vDsyXmJ_MksUWzt2jxcn3iAOKzXo0_SA/viewform
- E. Publish and share your pathways with others on the project website.
- F. Conduct you Learning Pathway with children and share the results with us using the Monitoring Grid:
https://docs.google.com/forms/d/e/1FAIpQLSeDVuzW7zRzZXUe_2EvtPcacXjzarOjk8fwmxrAux20qyO_fA/viewform

Website

For further and updated information about this project please see: <http://kitchenlab4kids.eu/>

Social media

Facebook: <https://www.facebook.com/KitchenLab4Kids-109904723897139>

YouTube: https://www.youtube.com/channel/UCA7UdkiVACILTQ_hdLFJuyA

Video teaser

<https://www.youtube.com/watch?v=n-kj5XNlcvg>

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http://kitchenlab4kids.eu/?page_id=2125/#contacts



K4K - Kitchen Lab 4 Kids is an Erasmus+ KA2 project (2018-2021). The project aims at proposing interdisciplinary activities in an integrated teaching context that allows pre-schoolers to develop STEM skills while practicing exciting science at the same time.

Partnership:



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