Degree IN TEACHER OF PRIMARY EDUCATION
Subject: Science Education
Course: 2019-20

Chapter 3. Methodological strategies in Science Education

1. Methodological Strategies in Science Education

STEM (educational robotics)

The term STEM stands for Science, Technology, Engineering and Mathematics. It is used only to group the four significant areas of knowledge in which scientists and engineers work. The concept "STEM Education" has been developed as a new way of teaching Science, Mathematics and Technology together (in general, not only computer science) with three distinct characteristics:

- Teaching-learning of Science, Technology, Engineering and Mathematics in an integrated way instead of as compartmentalised areas of knowledge. Integrated instruction means the assimilation of concepts from two or more disciplines**.**
- With an Engineering approach to the development of theoretical knowledge for subsequent practical application, always focused on solving technological problems.
- The relationship between Mathematics, Science and Technology are inherent in these disciplines

In the 21st century, STEM education implies an educational evolution where Engineering (and its methods) are part of the Primary and Secondary Education curriculum. In the same way, the curriculum incorporated science and the scientific method in the 20th century.

This methodology aims at the learning of new concepts in Mathematics, Science and Technology and increasing students' interest in Science. It includes an efficient process of design and solving authentic problems, working as a team and building real solutions, as Engineering does in the real world. Thanks to this educational method, we see an upward progression in the use of technological materials in the classroom, such as **robotics**.

In a STEM Education,

- Students work in teams and learn to solve real problems through reflection and decision making
- They increase their capacity to solve problems in a creative way as well as individual critical thinking, their self-esteem and boost their communicative abilities

- First-person experimentation allows them to improve the retention of learned concepts over the long term.
- Through the explanation of hypotheses and ideas, they make connections between the objectives of problem-solving, and the processes carried out.

Flipped classroom

The education of the 21st century is changing considerably. New technologies are driving much more dynamic and interactive learning models and classes such as gamification, mobile learning and flipped classroom.

Flipped classroom suggests transferring work on specific processes out of the school to use classroom time to facilitate and improve more complex cognitive processes. Therefore, it proposes that:

a) *At home*: students access the contents of the subjects at home, study and prepare the lessons
b) *In the classroom*: students do their homework and interact by doing more interactive activities, analysing ideas and discussing among themselves.

The classroom methodology of the immediate future brings with it many advantages for both students and teachers:

- Flipped classroom adapts more quickly to the rhythm of each student, which allows the student to move forward with less pressure and with a customizable material on many occasions.
- It allows much more interactive and participative classes to prepare debate activities, resolution of doubts, games, practices...
- Evaluations are no longer "traditional". They are focused on how students develop content, their contribution to knowledge acquisition and to deepening the topics. This part of the flipped classroom is related to what is known as connections.
- Family members also become essential support because they can participate more in the content of their children's education and training.
- It promotes teamwork spirit, very useful in a future working world. Also, it reduces cases of (cyber)bullying, as well as communication problems in the classroom.

From a technological point of view, access to content through ICT makes students look for or need to know how digital resources work.

2. Activities in experimental sciences

First of all, we must differentiate between educational activity and an educational task, because they have a daily use without distinction, which can create confusion. In that sense, we can say that:

Educational activity: It is an extensive and variable work that responses to its own purpose/objectives/competences/contents and has its entity as a part of a teaching unit. It should be evaluable and evaluated.

Educational task: It refers to concrete work related to answering a specific question. Teachers can use them to evaluate.

Starting from this point, we can consider the following question, **what are the activities?** In definition, they are organised, and oriented sets of school tasks focused on the acquisition of specific

learnings. To be more precise, we can distinguish between the activities of the teacher and the students.

About the teacher's activities, the teacher must carry out the presentation of the content to work using different resources such as verbal communication, graphics, audiovisuals, digitals. Also, the teacher must drive and guides the activities of the students in terms of methodology, protocol, organisation…of the activity.

About the student´s activities, they are organised, and oriented sets of school tasks focused on the acquisition of specific learnings and should be carried out by students. These activities must be understandable, miscellaneous, viable, significant and related to new fields of knowledge and practice.

Types of activities

These activities focus on students according to:

Requirements in its realisation	**The objective of the activity**
➢ Tasks on the text ➢ Tasks of organisation and structuring of contents ➢ Expression activities of previous knowledge and personal conception ➢ Activities of search, organisation and elaboration of various information ➢ Activities of expression of information elaborated by the students ➢ Outdoor activities/excursion ➢ Argumentation activities ➢ Practical/experimental activities	Initial/motivation activities Development activities Synthesis activities Evaluation activities Interdisciplinary activities Activities related to transversal issues Attention to diversity (reinforcement and extension) Extracurricular activities

Below, we will describe the different types of activities based on the requirements to carry them out:

Task on the text

Purpose	To help the learning of the conceptual aspects
Type	Search for information in the textbook to find answers to closed questions
Characteristics	❖ They imply a comprehensive reading ❖ They are aimed primarily at conceptual learning with little impact on procedural learning
Example	*Escribe en el recuadro verdadero (V) o falso (F), según corresponda.* _____ *El suelo está compuesto sólo por materia sólida.* _____ *El suelo tarda miles de años en formarse.* _____ *Las plantas son fundamentales para formar suelo*

Tasks of organisation and structuring of contents

Purpose	To help to learn the conceptual aspects in a multimedia material and promote the development of skills and procedures
Type	❖ Summary from a text, a movie, a book ❖ Development of conceptual maps ❖ Resolution of qualitative issues

Characteristics	❖ Intellectual demand: requires restructuring and content development sometimes absent in books
Example	*Copia las propiedades de los gases seguidas de un ejemplo que explique cada una.* *Los gases pueden comprimirse* *Los gases tienden a ocupar el mayor espacio posible* *Los gases no tienen forma propia*

Expression activities of previous knowledge and personal conceptions

Purpose	To help students express and be aware of their previous knowledge and their conceptions
Type	❖ Answers to questionnaires or interviews ❖ Dialogue/Group discussion ❖ Brainstorming ❖ Production of some document or material
Characteristics	❖ At the beginning of the Teaching Unit or section ❖ Facilitate reflection and communication
Example	*¿Qué sabes sobre la respiración? Sin duda, has observado tu respiración muchas veces, y seguramente, ya tienes tus propias ideas sobre ella. ¡Exprésalas a partir de estas propuestas de actividad que ahora te sugerimos!* *Haz el dibujo de una silueta humana y dibuja, dentro de ella, todos los órganos que tú crees que intervienen en la respiración.* *Cuenta, como si fuera un viaje, el camino que hace el aire desde que entra en tu cuerpo hasta que sale. Por supuesto, tienes que contarlo tal y cómo tú te lo imaginas; luego, ya veremos qué tal está lo que has contado.*

Activities of search, organisation and elaboration of information

Purpose	To promote the development of skills and procedures, related to the search, construction and interpretation of information of varied sources
Type	❖ Bibliographic works on a topic
Characteristics	❖ The students prepare it after a search, systematisation and organisation of the information from different sources
Example	*Amplia tus conocimientos* *Encuentre información sobre diferentes tipos de energías renovables y exponga las fuentes de donde obtiene la energía.*

Outdoor activities/excursions

Purpose	To work theoretical aspects in activities outside the classroom to motivate, work attitudinal and internalise the contents better
Type	❖ Museum visits ❖ Excursions to places, parks... ❖ Private/public companies ❖ Cities/towns (culture, socio-scientific aspects)
Example	*Visita al Museo Principia* *Visita al torcal de Antequera* *Visita al Paraje Natural de la Desembocadura del Guadalhorce*

Activities of expression of information elaborated by the students. Argumentation

Purpose	To promote the development of skills and procedures related to communication, based on information developed by the students
Type	❖ Oral presentation of results of a work-sharing of group results ❖ Written test/Reports ❖ Audiovisual/body expression
Example	*Pensad una forma de ahorrar agua en el colegio. Confeccionar un mural con este tema y una presentación*

Practical/experimental activities

Purpose	Development of procedures, techniques and skills such as observation of objects and processes; experimentation, handling of instruments and devices, measuring, posing questions and hypotheses, inferring, predicting, classifying, planning, collecting samples and data, representing data and drawing conclusions
Type	❖ Experiences: Mainly to obtain a perceptive familiarization with the object and phenomena ❖ Practical exercises: Mainly intended: o To develop practical skills (measurement, manipulation of instruments, data processing, diverse techniques) o To develop intellectual skills (observation, classification, emission of hypothesis, the design of experiments, control of variables, communication of results…) ❖ Research: Designed to allow students to solve problems working similarly as scientists or technologists. Examples of questions that lead to school investigations: What material of a given series "holds more"? What is kitchen paper "better"? Is the tap water pure?
Characteristics	❖ In the class or outside ❖ Directed fundamentally to procedural learning and understand how the scientists work ❖ Experimental activities with the same content can constitute an experience, an exercise or research
Example	*An activity based on the separation of the pure substances that make up a mixture (for example, the separation of salt and water from a solution of both) can constitute:* • ***An experience****: If our interest is mainly to perceive that a homogeneous system can contain more than one component, observing that when the water evaporates, the salt precipitates.* • ***An exercise****: If our interest is to learn the separation technique* • ***Research****: If separation is the method to solve the following problem: is tap water pure? Moreover, students have to find a way to answer this question*

To conclude, we can ask the following question: ***How to carry out experimental activities?*** Students´ requirements depend on the presentation of the activity and their level of inquiry according to the ILI, (The Inquiry Level Index).

The Inquiry Level Index (Herron, 1971)

It is an instrument to classify experimentation activities according to the level of inquiry required for students to complete them. It involves the role of the students to carry out independently them.

ILI method has four levels:

Level 0: Students receive the question, the method and the answer

Level 1: Students receive the question and the method, and they have to find the answer

Level 2: Students receive the question, and they must find the method and the answer

Level 3: Teacher indicates a phenomenon and the students have to ask a suitable question and find a method to answer it