Archi-tecton- Archi-tectus*

Age-group: 6-9 years old
Number of hours: 25 hours
Short description of activity: Students propose an architectural solution for a new public sports center/music school in the school's area. They start with the analysis of real buildings and develop a prototype for their proposal.

CT-competences:

- Pattern identification/Coding
- Problem Decomposition
- Debugging
- Abstraction
- Logic
- Algorithm

Goals

- Development of team and individual work habits, efort, responsability, self-confidence, curiosity, personal initiative, interest and creativity in learning, and entrepreneurship.
- Development of elemental math skills and transferability to daily life: problem solve with basic calculation, estimation, computation and geometric knowledge.
- Use of different art and visual expressions.
- Use of ICT for search information, process simulations and conclude.
- Developing reflective thinking: Students must reflect on the social service in a town. (What do people need for a healthy and full life?). They must reflect on what their building is for (sports or music) and design accordingly too. Students reflect on the parts of a building. They are challenged to decompose a building into parts depending on its use or its construction: set of rooms with different uses, a set of basic construction elements like walls, floors, roof, etc.

Realistic STEAM-context

The municipality is interested in a better town for the people and the Major thinks that a good town for the children is a good town for everybody. Then, all the children of the class are invited to participate in the proposal for a new public space in the school area or municipality. Teams will choose to propose either a Sports complex or a Music school. They will be asked to justify their choice according to their needs. They have to present their projects to a committee and get a Quality pass for their proposal according to a rubric.

** Achitecton is the translation of the Greek term and architectus is the Latin version. "Archi": the highest, the superior, the first of all, and "Tectus": work, construction, factory. The children must feel like architects.*

Contents

Experimental and Social Science

- Material properties and social use of materials, recycling, energy efficiency, sustainable development
- The origin of the buildings materials
- Hot and cold. Temperature and thermal conduction.
- Natural lighting, light as energy form
- The seasons and the position of the Sun
- Climate and climate elements
- Orienteering and cardinal points
- Historical and geographical contexts
- Time, time orientation and ages of history
- Architecture and engineering as a social discipline
- Historic and cultural heritage
- Scientific method

Math

- Geometric shapes (especially rectangles and triangles) and geometric volumes
- Different ways to measure and estimate figures dimensions
- Symmetry and pattern recognition
- Location on the map and in space

Technology and Engineering

- Planification and realization of projects, report presentation.
- Engineering design cycle: Analysis of the problem, design of a solution, prototyping, evaluation, improvement. Quality control and evaluation.
- Technology: Creation of a tangible (scaled) prototype with diverse materials. Supporting or supported structures. Enclosures and roofs. Domotics.
- Machines, devices and their use.
- Construction of simple structures using modular elements to solve problems or with a specific use

Arts

- Aesthetics and fashion
- Ergonomics and functionality
- Art and cultural heritage.
- Personal ideas representations by the use of the visual language elements.
- Imagination, draw and elaboration of three-dimensional artworks with different materials.
- Visual arts use of geometry elements identificated in the pupil´s real environment; connection with the math geometry lesson concepts.

Others: Language, social and civic values

- Oral comprehension and expression. Coherent speech. Respect listening and speaking time
- Writing of objective texts
- Development of autonomy and the capacity for entrepreneurship in order to achieve personal success by taking responsibility for the common good.
- Contribution to the improvement of the group's climate by showing cooperative attitudes and establishing respectful relationships.

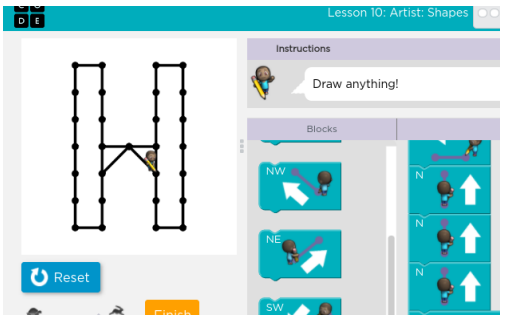
- Cooperative learning (teamwork favouring positive interdependence and showing solidarity).
- Began to understand the sense of social responsibility by using the capacity for reflection, synthesis and structuring.

Methodology

Based on learning by doing (with different levels: from imitation to creation)

Part	Description	Timing
1	**Entry point** Students are told the realistic context of the project. After the class-group tasks, the teacher sets the challenge for small working groups (3 or 4 students): planning a useful, durable and beautiful building for the community. Class-group tasks: a) Public and private buildings in the school area will be analyzed and discussed, together with their use and functionality. b) As an "artstorming" the teacher asks every child to draw how it could be her or his dream building. If the teacher thinks it is necessary can motivate with some of the illustration works of Federico Babina (for instance: Archimusic, Archist, Earthitecture or Architale, are good to see with the children).	1 or 2 periods
2	**Began and learn to work together** The first task for the working groups is the **Marshmallow challenge**	1 period
3	**Building design** The teacher questions about the requirements for the building proposal. They will be asked to answer questions like functionality, Interior and exterior design, budget, foundation, etc.: What are the essential elements? What is important in a Music School or in a Sport complex? How it must be? This is a brainstorming moment. The most important at this point is the work groups create lots of new ideas (creativity): - What do we use it for? - What does it look like? (inside: how many rooms, doors, windows, sizes, materials.../ outside: entrance, walls, roof, garden...). - What do we need inside the building? What do we need outside the building? - How could it be more beautiful? After a free work time, the spokesperson of each group exhibits the solutions and all the class group debate about the better options. Children are provided with the rubric explaining the requirements for the building proposal. The work group reflects again how to improve their proposal and the secretary writes on their "*Project memory*" (portfolio) the conclusions about,not only their proposal, also what they have learned during the class sesion.	1 period
4	**Shapes and geometry**	1 period

	We present two options for the working groups task about geometry and daily life. In both situations it is important to have a period of time for final assembly (formative assessment). The teacher asks the students about what they learn and the group secretary takes note of this in their *Project memory*. Option 1: - In a tangram-style of game, students are given cardboard shapes and front pictures of important buildings in their surroundings. They are asked to replicate the shape of the given building with the available materials. For younger students pictures and shapes should match in size to allow the reconstruction to take place on top of the picture, while older ones are recommended to work in different scales. The same exercise will be reproduced with 3D blocks if available. Free play with the shapes and volumes should be encouraged afterwards asking for adequate explanations on differences and similarities between buildings and their function. Option 2: - Children build triangles and squares with steel balls and magnetos or toothpicks and jelly beans, plasticine or modelling clay; afterwards build 3 towers: one only with triangles, another only with squares and the third one using both elements. What is the best? Why is it the best? Teacher reflects with the class group of children about the capacity of triangles in structures. Them propose to look and find triangles in the building and other town elements or structures like bench, bridgeds, electric towers, etc.	
5	**Building along the time** The teacher offers the opportunity to become aware of time orientation and Historic Ages through the use of pictures of unique or special living spaces or buildings. Each work group will have one or two pictures of buildings and cloth pegs. The teacher will put a rope from one side of the class to the other and the students will have to place their images in the corresponding place creating a chronological axis. After all the pictures will hang the teacher will discuss with the class group if the chronological axis is correct or not and why it is. As in other occasions the work group reflects together and notes down what they think before and what they think now, what they learn and how they learn it.	1 period
6	**Buildings around the world** Children in groups choose one or two buildings from a limited list provided by their teacher and research using internet search skills. The list must include examples from famous (or not) buildings around the world in different continents, situations and different functionalities. The condition is there is information about it on the Internet. (This Google slides presentation has some examples)	2 or 3 periods

	Students need to find the following information: Location Height Use Date built After they research one member of each work group will place the name or a picture of these buildings on a map of the world in the class. This part of the project allows us to work on Geography contents (Geo Astronomy -orientation of the building- and Climatology) and also introduce the concept of 'map' to students. Other important aspect are: - **Critical thinking skills**: Which building is the most beautiful? Why? Is it important for this kind of building to look good? As ordinary, members of each work group reflect together and write down what they have learned and how they learn it.	
7	**What is important to draw a building?** This stage of the project has three tasks and can be done in an ICT class. The sequence of task allows demonstration with a simple square and triangle to create a house (Abstraction) 1.- Teacher challenges the students to represent the buildings with only a few straight lines. We can use the same buildings studied before. 2.- After a time of reflection and free work in the work groups the teacher shows the students examples of abstractions and asks them to match the drawings to the photos of the buildings.   3.- Coding challenge: In pairs create an algorithm using compass points as commands (i.e. 'North' is up, 'East' is left etc). This can be done as an 'unplugged' activity on a piece of paper with grid lines or with a coding website such as [code. org](code.org)  Again, at the end of the class period, the pupils note down at the *Project memory* new progress of their learning.	1 period
8	**Building layers**	1 period

	The students discuss the decomposition of the buildings in the school area that they study in the first step of the project. The decomposition isn´t by their shapes or volumes, but using the construction's layers: Foundation, supporting structures, walls, enclosing, roof, outside decorations, inside decorations. Children should be helped to reflect on energy efficiency, materials and the like. Connections to geography through the climate (pointed roof, orientation, environment, etc) should be researched. Interior design and its functionality should also be analyzed, as well as the presence or not of artificial intelligence devices (domotics).	
9a	**How important are the materials you choose for your building?** **Introduction:** Show the students the video of (or read a simplified version for literary skills) the story of the 'Three little pigs'. After watching, ask the students: What materials did the pigs use? Which material was the best and why? **Exploring materials:** Students remember previous sessions of the project and compare the materials that are used in buildings around the world and in different layers. Adobe, cement, concrete, reinforced concrete, plaster... This gives us to talk about the properties of the materials and the efforts they support. In class we use mud, mud with straw (adobe) and "reinforced" adobe with aluminium rods to reinforce the structure. We reflect on the use of each one. If mud is very cumbersome, we could use some modelling paste. We explore other important materials and their use as insulation and for human comfort (for instance, glass allows light to pass through, wood is a heat insulator). Sense of exploration is very important at this moment. Teacher presents to the students some cards with a picture of the materials they have explored and others (wood, glass, straw, metal, plastic, bricks, paper, etc.) and, if it is necessary, they in the small work group look for their properties on the Internet. Below, students have to relate the materials to the part of the building where it is located and the properties it has. Then in assembly, they explain what they do and the terminology is modified if it is necessary to introduce the new vocabulary (transparent, opaque, strong, hard, soft, flexible, insulator,…). To make the relationship more visual they can be given a picture of a building under construction and have the pictures or cards placed in the right areas, then it can be placed in the classroom as a poster. To finish, students think about their prototype of building using **logic** and write down on their *Project memory* sentences similar to these: To let light into the building we could use:_____ To build stable and strong walls we could use: _____ To make curvy shapes we could use: _____ To keep the rain out we could use:_____	2 periods
9b	**Time to make our own brick: creating an algorithm and debugging** Tell the students that an algorithm is a sequence of steps that does something we want it to do/it's useful. For example a cooking recipe is an algorithm. Now they are going to create an algorithm to make a mud brick. 1. Hand out activity sheet	2 periods (+time to the brick dry)

	(option: the students could work out the best proportions of soil, water and straw by trial and error - this way students will be '**debugging**' in order to get the right proportions. Is the mixture too wet? too dry?) 2. When the students have finished **sequencing** the steps they can compare with other groups. 3. To check their answers the students can watch this video. 4. Students in their groups follow their corrected algorithm to make their mud brick mixture. It will get messy!	
10	**Architecture as a form of art** Study the value and the meaning of buildings. Which parts could have been designed in a different way? Why are there trends in architecture? What do we know about a city's history from its architecture? Children are proposed to represent (drawing or using other visual techniques the teacher prefers) their design building, paying attention to details and non-functional parts (if any).	1 period
11	**Building construction** Children work on the construction of a prototype for their own building, a document containing the answers to the rubrics questions, and prepare a presentation of their project. Recycled materials will be used but will be made scarce, so as to encourage children to plan ahead their needs. Older children may be asked to work according to a budget (included in the design phase).	2 or 3 periods
12	**Preparation of the presentation** Once the prototype has been built, the presentation is prepared, which must include the solution to the project, the reasons why it has been built and the background of what they have learned and what has led them to do so. It is important that the mistakes, changes, doubts that have arisen and the solutions that they have taken in the group appear.	1 period
13	**Building presentation** Once the children have selected the most important information in their portfolio to prepare the presentation, it could be very interesting that the children link the difference points or learn contents to an artistic idea than they feel is important to express the building idea (it could be a piece of music, a picture or whatever) at the oral presentation moment. Optionally, the groups can do an oral presentation or a report that could be shared on-line with the families.	1 period

Organization

Materials:

- Pictures, cardboard, paper, glue, clay, coloured cords, drawing material, geometric blocks, toothpick, etc.

Use of ICT: (only mention when relevant)

- Office or similar (Word, Excel, Paint, Power point …)
- Internet connection
- Free software: SketchUp and Code

Opening of classroom: (only mention when relevant)

- It is interesting the student can go out at least at the beginning of the project to observe the school surroundings.

Coaching

Useful questions:

Part 1

- How is the building? Where is it? (The position in the town/city), How many windows, size of the windows, glass roof, Sun exposure/orientation, etc. How many people use it?
- To give a little urban sense to the buildings is important to reflect with the children about questions like: How are the buildings distributed? Where are the parks? If there are car parking spaces next to the school ask the children Why is it? Etc.
- As this is a transdisciplinary project, it is important to link the concepts of cultural and art heritage to the visual and audiovisual experiences (to live and to create).

Part 2

- At the Marshmallow link are some useful questions to reflect about the team work. Here are other questions linked to the building topic: What factors were important in the construction of the tower?
- How do you make the structure solid/how do you keep the structure from falling down
- Why burden sharing is important

Part 3

- At this moment, Engineering and Science contents are introduced ('plan', forms and materials, orientering) but these concepts must be developed at next work sessions.
- Also Critical thinking skills (reflection on the requirements of the building and deciding their importance) and Computational thinking skills (abstraction:challenge the students to represent the building with only a few straight lines; differentiation: to know the difference between plan and map)
- What is fundamental for your building to have?
- Why do you need that building?
- Choice of materials vs cost vs environmental impact
- It could be an interesting task to look for Vitruvio on the Internet with the children. Vitruvio wrote the most ancient book about architecture that we have (actually are 10 books). He´s idea about architecture was that it must be an imitation of nature. As a nest is perfect for a bird or a honeycomb is perfect for the bees, Vitruvio said that the public buildings must be "*firmitas, utilitas, venustas*" in other words: solid, useful, beautiful. For instance, a useful school of music building needs good lighting and sound insulation for the classrooms and a big room for the auditorium with good acoustic conditions. We can see with the children beautiful buildings that achieve the two other Vitruvio conditions like the Pavilion 21 Mini Opera Space (Coop. Himmelblau) for the Bavarian State Opera, Tenerife auditorium Adán Martín (Calatrava), the Lisbon School of Music (J.L. Carrilho da Graça) or the Philips Pavilion (Le Corbusier and Iannis Xenakis) for the Brussels Universal Exhibition 1958.
- It is possible they work on a rubric in order to design a new sports complex/music school that will fit the social needs, functional needs, and aesthetic function for the building. Younger children will be given the list of needs, while older children can work that list themselves with their teacher's help.

Part 4

- Why is the triangle a widely used figure on buildings? What does triangle mean and why is it

useful?

Part 5

- It is important to break the triumphalist idea of History. Not always the oldest buildings are the least developed or sophisticated. The buildings answer to the different ways of life. For instance, the nomadic tribes do not need durable buildings, the caves have ideal conditions to refuge (steady temperature in a solid wall space) and to prepare the refuge people don´t need an energetic waste.

Part 6

- Orientation of the building: In which parts of the building will the sun shine according to the time of day? Which parts receive more hours of sunshine and which less? How does the sun affect habitability and energy efficiency?
- Climatology: The importance of climate (rainfall, temperature, hours of sunshine) in the design of the shape of a building. Importance of climate in the use of natural resources: solar energy, wind energy and use of rainwater.
- Ask the student to compare and contrast buildings from different parts of the world
- Is architecture based on human needs? (Ergonomics, adaptation for disabilities, functionality, etc.)
  We can find elevated buildings in different parts of the world. Why? What are the conditions or the functions of those buildings? What do they have in common?
- In the list offered to the students we should choose unique buildings connected to people's lives, not just famous buildings (which can also be there), buildings that are unique in their function and relationship to their surroundings. This allows a deeper reflection about what architecture is. For instance, an office tower responds to this need and also has this impressive aesthetic function in the middle of the city. Whereas a farm or a farmhouse does not need to attract attention, but they can be very intelligent buildings, with their stables, hayloft, vegetable garden... They are designed to the millimetre for the people who live there, and they can also be very beautifully integrated into the natural landscape. A large tower, however, can be very aesthetic, but in the middle of the mountain it would spoil the landscape.
- Do building materials change from one place to another? Why?

Part 8

- How can we design structures that support what is above them?
- How should the walls be?
- What is our position on planet Earth? Does that position influence the orientation of our building?

Part 9a-9b

- What materials can help meet human needs such as light and heat?
- Why do we use aluminium rods in adobe? What does it bring? Is something similar done in the buildings we see around?
- Which materials are warmer/colder? Why do modern windows have two panes of glass separated by an air space and the old ones only one? (It gives rise to talk of thermal conductivity after explore it)
- If we want the building to have as much sunlight as possible, how should we orient it?
- Not only the most expensive materials are long-lasting or most efficient energy. Some millennial buildings adobe (sun-dried brick) or mud maked are still erect. The sun-dried brick walls generate ideal conditions in extreme climates and are real cheap. We can reflect in a similar way about wood or bamboo as building materials.

Part 10

- Do the "non-functional" parts of a building have a function?

Stimulation of self-management: (concrete opportunities/remarks adapted to the project)

- Leadership development
- Self-study
- Stimulating Research
- Development of critical thinking
- Auto-assessment

Stimulation of cooperation: (concrete opportunities/remarks adapted to the project)

Teamwork:

- Groups consist of 4 students.
- Competences needed in a group:
    - leadership
    - synthesis capability,
    - coordination, mediation
    - creativity

Formative assessment: (concrete description/summary adapted to the project)
The assessment will be based on:
1.- The teacher's general observation: group and individual processes and results
2.- Assemblies focused on problem solving and critical reflection.
3.- The achievement of specific objectives by the group in each of the parts of the process.
4.- Revision of each task to analyse successes and errors, the groups obtain points
5.- Final group "Project memory" (Portfolio: Writing report, draws and pictures of the prototipe)

Adaptations

General ideas:
In the 3-6 ages: the part of urban analysis is reduced/eliminated, the manipulative construction is mainly encouraged, the algorithmic part of brick creation (with debugging) with manipulative materials.
In the 9-12 ages: the activity can be kept very similar, deepening the reasoning and including structures that were not contemplated before (pillars, arches...)
In the 12-15 ages: a much more in-depth urban analysis and a more detailed project (bathrooms, corridors... that think about the different routes of people, evacuation routes...). Design in the 3D modeling program SketchUp.

Tips & tricks

(only mention when relevant, e.g. background information, …)