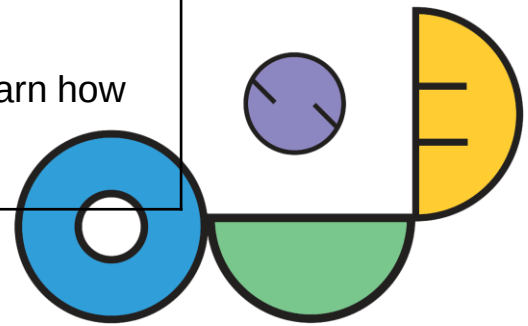
Authentic practises: content integration

Description of the activity:	In this document you will learn about the how to integrate the different elements Science, Technology, Engineering and Maths together in one STEAM activity
Target group(s):	Primary and secondary schools
Keywords:	Design, Inquiry, optimization, content integration
Duration of activity:	45’
Description of activity environment and materials needed:	see also the handbook and hand outs on content integration ‘design and inquiry’ What do we exactly mean by “Inquiry”, “Design”, “Optimization”? We learn about the underlying principles and models of STEAM education, and learn how to integrate it in STEAM activities. We use a concrete STEAM activity to explain the models: Shadow Art



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Content integration
Authentic practises

- Design
- Inquiry

Activities from former KA2 Erasmus projects such as STEM4MATH (www.stem4math.eu), STEMcomputer (www.stemcomputer.be), STEAM IT (www.onderzoekendleren.be), STEAM CT (www.steam-ct.org)… can be used to experience how "design" and "inquiry" can be integrated in activities in order to create good STEAM activities…

For example:
GP1: Shadow Art (https://www.stem4math.eu/shadow-art)
(target group: primary education)
Children discover how shadows are formed. They create an artwork with shadows and recyclable materials. They draw a floor plan of their artwork.

Within good STEM education, everything starts from **problems** which are situated within **relevant (authentic) contexts**. In order to **solve these problems** the content and skills which are related to the different STEM disciplines are integrated and used in order to find answers and solutions for these problems. This happens **in an iterative process in which Inquiry, Design and Optimization are central elements**. (Van De Keere & Neyrynck, 2020)

What do we exactly mean by "Inquiry", "Design", "Optimization"?
By doing and reflecting upon this kind of activities we can explain the meaning of "Inquiry", "Design", "Optimization" and link them also to the different STEM disciplines and how they are tackled in the activity.

The activity

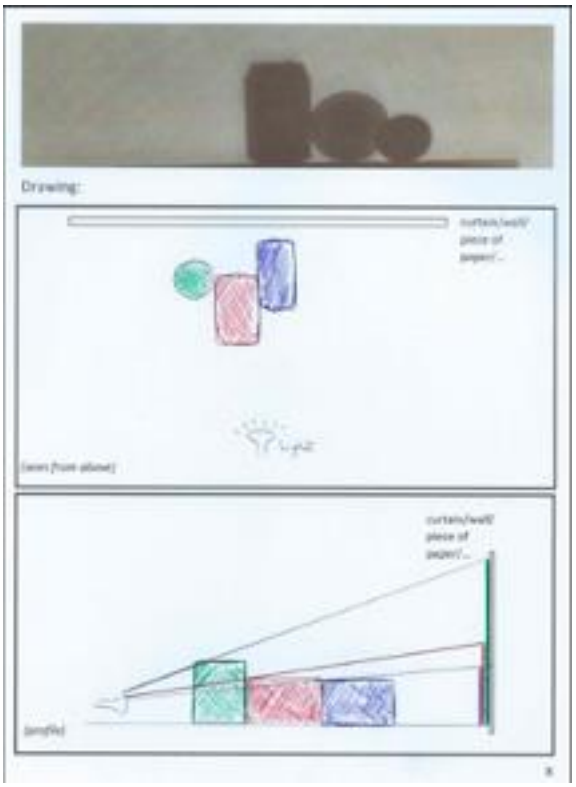
When the students enter the classroom, they see that there are a lot of pictures of artwork on the walls. "The classroom is a museum," the teacher says, almost in a whisper. "Choose one work of art that appeals to you the most." The students are trying to find out how those works of art were made and they are challenged a little later to construct a shadow work of art themselves


In a first task in the activity, they discover how to make a shadow and how to make it larger or smaller, using a light source (lamp), a number of objects (cans, bricks) and a screen. They learn, among other things, to "collect data in a systematic manner" by controlling variables, making connections (if ... then ... formulating relationships) and drawing conclusions by analyzing data.

- If I move the thin can closer to the screen, the shadow becomes smaller, … If I move the thin can closer to the light source the shadow becomes bigger.
- I need to change one variable and keep the other ones in the same position to get knowledge about how shadows are formed.
- How to collect the data? …

Elements of inquiry: (NEED TO KNOW how shadows are formed)

- Searching for an answer for a scientific question related to scientific concepts (creating shadows)
- Through the process of inquiry. (inquiry circle)



E.g. Collecting data

Conclusion

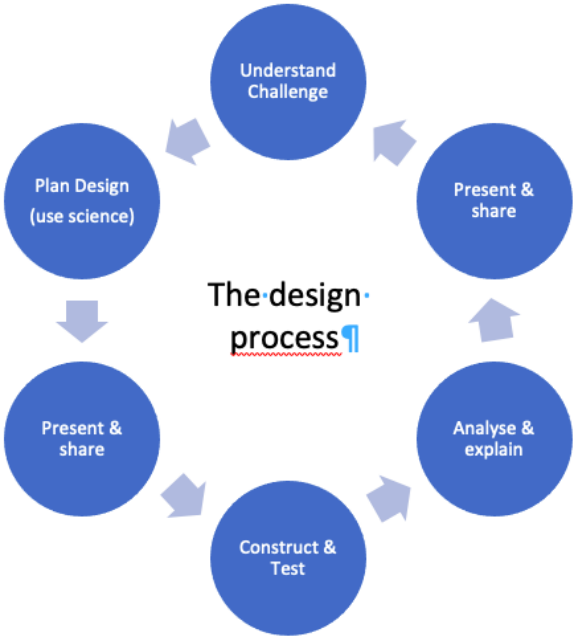
So 'inquiry' is not just 'conducting investigations' in which children have to follow a 'step by step' plan in order to 'visualize' or 'explain' a scientific concept. Inquiry is about solving 'scientific questions' in a 'scientific way'. In order to guide us through this challenge we use the inquiry circle and by doing this we are applying and learning inquiry skills.

In the ‘Shadow Art’ activity children also have to ‘design’ a ‘system’ in order to fulfill a certain need. They have to make their own “Shadow Skyline”, based on some criteria. Criteria can be :

- We need to see 5 buildings
- One building is twice as big as another building
- We need to see a window in a building, and also a chimney
- …

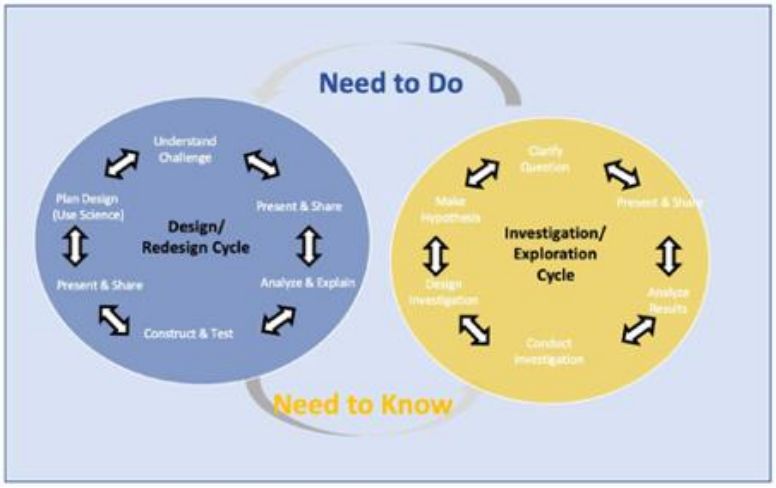
A central element of technology is designing ‘systems’ in order to fulfill in a material need. (TOS21, 2008)

Similar to ‘inquiry’, a systematic process orientated approach is needed (design circle). But there is a different goal and another finality. The goal of inquiry is finding answers to scientific questions and the answer is an explanation based on scientific concepts. The goal of design is finding answers in order to fulfill material needs. Therefore something will be designed and made. Different results / constructs are possible as outcome of the ‘design’ process, while the result of the ‘inquiry process’ is one theoretical explanation.



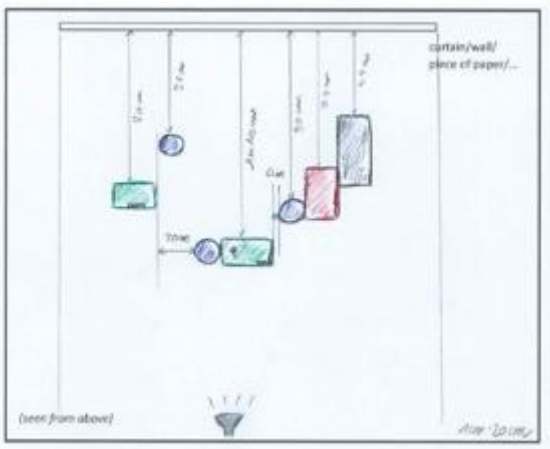
In the ‘Shadow Art’ activity we also used criteria so that children had to take into account certain elements while constructing their piece of Art. As a teacher, setting criteria, helps you to coach the activity. Based upon the criteria you can do some intermediate evaluations and stimulate children to optimize their construct based upon the criteria.

In fact in a STEAM activity “Design & Inquiry” interact with each other



About mathematics

Mathematics is still too often treated stepmotherly in STEM activities. A STEM approach can make math really meaningful to students. For example, abstract and often difficult mathematical contents suddenly become much clearer because they are used to achieve a certain goal in a STEM activity. This mainly concerns applied mathematics, such as calculations (counting, sorting, ranking, scale calculation, area measurement, ...) and being able to express and analyze relationships mathematically (measuring, making a model, drawing a graph, filling in a table, ...)



In the example of the shadow artwork, students needed to use mathematical concepts and find out relationships between variables (closer, further, if ... then ... relationships, ...). As soon as the shadow artwork is finished and fully meets the criteria, one can propose to the students to also set up the artwork during an open school day. But how do we rebuild them so that we can exhibit identically the same Piece of Art? The students will have to measure in order to draw a map. This can also be done on a scale. In this way, numerous opportunities are created to make mathematics more meaningful and to apply it.

Another example … Perseverance Rover landed on Mars on 18/02/2021

The activity starts with offering a socially relevant context: why is it useful to explore Mars? During an activity about launching the Perseverance Rover to Mars, tests must be carried out so that the space capsule with equipment could also land safely on Mars.

The students work from that context as real researchers. As a "prototype" for the extremely fragile equipment, they use an extremely fragile object, for example an egg.

The central point here is to design ‘a space capsule’ that protects the egg. Children can use different materials and tools for this. In order to achieve a successful design, an (intuitive) understanding of scientific concepts such as "extending the braking distance" and "spreading of forces" is necessary, and some investigations will be conducted in order to design a successful space capsule.

Other examples

GP3: Buzee bees (https://www.stem4math.eu/buzzy-bees)

Children learn about the life and behaviour of bees. They experience the advantages of hexagonal structures, such as the honeycomb, and try to decode and read the language of bees.

GP4: Soap box race (https://www.stem4math.eu/soap-box-race)

Building a unique soap box car is fun, but it’s also challenging. Students need to find out how they can build a soap box car that can reach the finish downhill as fast as possible. Each team creates an rganize prototype of a soap box car to rganize their own race!

GP5: Composing Music (Steam-CT)

Children explore the rhythm and melody in a piece of music and create their own piece of music by programming rhythm and melody (e.g. in scratch)

GP5: Mission to Mars (https://www.stem4math.eu/mission-mars)

Problems to be tackled: Students will be challenged to build a water rocket that can be launched as high as possible. There are a lot of factors involved with water rocket launching.
