Youthworkers resource pack

Mind matter

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Content

Introduction 2

Step 1 - Forming a guiding question 3

Picture 1 - MOM cards 4

Activity: 5

Step 2 - Brainstorming answers 6

1. Quickfire rounds (for a class/larger group) 6
2. Slightly less quickfire round (for a class/larger group) 6
3. Narrowing down an interesting question (solo or groups) 6

Step 3 - Prototyping 7

An introduction to Micro:Bits 7

Step 4 - Iteration 10

Face to face piloting: 10

Online piloting: 11

Step 5 - Presentation and Documenting 13

Methodology improvements developed based on piloting 14

Mind over Matter methodology description 17

Introduction

The objective of the Mind Over Matter (MOM) project is to increase motivation among young people (13 – 18 years old) to continue their further education in the STEM field (Science, Technology, Engineering, Mathematics) by creating and implementing an innovative, hands-on, inquiry-based methodology that will demystify science and scientific processes. By integrating Arts into the project (STEAM,) creativity and imagination become central to the design process and introduces scientific practices to creative subject inclined students. It integrates arts thinking with scientific thinking, removing the artificial barrier between them.

This resource pack will explain how to use the MOM cards to organise an educational activity using the STEAM methodology as either a short, medium, or extended project.

The MOM cards and a playable online version can be found at https://steamproject.eu/cards/

The **MOM cards** are a fun way to gamify the design process and create lots of possibilities and projects in a short amount of time. The activities can be adapted to suit your circumstances, and the steps outlined here are more of a guide than a strict set of rules to follow.

You can choose which version of the project you would like to work towards, depending on your circumstances. We start each version with the MOM cards and use them to **create a question**. This question is what guides the rest of the project. Each version of the project should end with participants creating a short presentation about their ideas and their answer to the question they created.

Short Version (half a day)	Guiding question	Brainstorm	Presentation		
Medium Version (2 days)	Guiding question	Brainstorm	Prototype	Presentation	
Extended Version (4 to 5 days)	Guiding question	Brainstorm	Prototype	Iteration	Presentation

Table 1 Version of the MOM card game

Further in the text you will find detailed description on how to use the methodology with young people, the one used in the testing phase and remarks about extension of activities based on our testing with more than 500 young people.

If you are interested in the impact of developed methodology on young people interest toward STE(A)M education and career you can read the research results in English or STATE NATIONAL LANGUAGE.

Step 1 - Forming a guiding question

A guiding question is a useful way to create a new area of investigation and design thinking. By merging four of the MOM cards, we can create thousands of different questions to guide our project.

There are 4 types of cards to pick from:

Arts

UNSDGs

STEAM Career

Concept

Picture 1 - MOM cards

Arts	A wide range of different artistic practices.
UNSDGs	Each of the United Nations Sustainable Development Goals
STEAM Career	A range of careers that include STE(A)M
Concept	A list of words to prompt ideas

To **create a guiding question**, you need to pick one card from each type. You might end up with:

Musician - Zero Hunger - Botanist - Create

A guiding question from these 4 cards might be:

> How could a **Musician** and a **Botanist** work together to **create** something to help with the **UNSDG of Zero Hunger**?

Or you might get:

Artist - Zero Poverty - Civil Engineer - Improve

How could a Civil Engineer work with an Artist to Improve conditions to help achieve the **UNSDG of Zero Poverty**?

NOTE: We don't need to answer these yet!

It's a good idea to practice forming questions before moving on to brainstorming ideas.

Activity:

One game that can be played involves having participants **race each other** to see who can come up with as many different questions within a specific timeframe, replacing a card each time they have created a question.

Step 2 - Brainstorming answers

Once you get used to creating questions, you need to move on to **brainstorming some answers to those guiding questions**. When you are brainstorming ideas, it is important to not dismiss any idea that comes to mind. Even if it seems impractical, seemingly impossible, or utterly ridiculous!

Here are some games to play with the cards:

1. Quickfire rounds (for a class/larger group)

- In groups or pairs, pick 4 cards from the pack and create a question. If someone doesn't understand one of the jobs or one of the UNSDGs then put the card down and pick another card.
- The first person to create a solution to that question wins a point.
- In quick-fire rounds, we can ignore the laws of physics and the limitations of funding! What we are looking for is **quick ideas to get our creative juices flowing**.
- Keep going until all the cards are used.

2. Slightly less quickfire round (for a class/larger group)

- In groups or pairs, pick 4 cards from the pack and create a question.
- Allocate some time for students to research more about the UNSDG or STEAM career that has been picked.
- Using your new knowledge, brainstorm ideas that could answer your initial question. We can still ignore the laws of physics or finance!
- Once every group in your class has an idea, go around the class and have each group briefly present:
    - The 4 cards they picked
    - The question they came up with
    - Their potential answer to that question
- If you have time, other groups can ask questions about the ideas being presented.

3. Narrowing down an interesting question (solo or groups)

- Take the pile of cards for **Arts** and flip the top card over. If you find that card interesting, keep it. If not, put it on the bottom of the pack and try again. Keep flipping until you find a card that sounds interesting to you.

- Put this card to the side and repeat the process for the **UNSDG**, **STEAM Careers** and **Concept** cards.
- Young people use these 4 cards to **create a question**. This will most likely be the question that they will want to brainstorm a more realistic and feasible answer to. They can change their cards at any point and alter their question if they feel it needs to be tweaked.
- Allocate time for young people to learn more about the UNSDG and the Careers chosen. As they learn more about each card, they may get ideas that would fit a different concept word or a different arts discipline. They can choose to change those parts of their question to narrow down the focus onto something that they are interested in.
- Participants write down any ideas that might answer the question they came up with.
- Participants can use drawings, sketches, diagrams, flowcharts or any other method to communicate their ideas.

*If you are running the short version of the game **(Table 1 above)**, students can submit brainstorming ideas and sketches in a short presentation as the answer to the guiding questions they formulated.*

Step 3 - Prototyping

An idea may (or may not) involve some type of interactive element. You might want specific things to happen once a certain threshold is reached. Or you might want people to interact with an object in a specific way to measure data, or sound an alarm, or flash some lights, or move a barrier. If so then you need a way of controlling these things. Something like a microcontroller. Like a Micro:Bit!

An introduction to Micro:Bits

Micro:bits are tiny computers that allow us to measure various inputs and control various outputs. We create a little bit of code that will get downloaded onto the board that acts as the middleman between the sensing and the 'bits that do stuff'.

Inputs (things we can measure)

- Light intensity
- Button presses
- Temperature
- Sound levels
- Motion (pitch/roll/shake)

- G-force
- Magnetic field strength
- Compass
- Soil Moisture
- Wireless messages from other Micro:bits
- We can also attach a wide range of sensors using attachments and breakout boards. Including distance measuring, CO2 measuring,

Outputs (things we can control)

On the board:

- A 5x5 grid of LED's
- A Speaker

On the computer

- Game controllers via Scratch
- Plotting Graphs
- MIDI messaging for musical interaction

Attached to the Micro:bit

- Motors
- Servos
- Relays

There are many ways to code your Micro:bit, but it is easiest to start with this website:
https://makecode.microbit.org/

There is also a ton of fantastic resources and guides at the Micro:bit website:
https://microbit.org/

How to transfer your code to your Micro:bit:
https://www.youtube.com/watch?v=-FZ8yTnoozY

Inputs and Outputs:
https://www.youtube.com/watch?v=NkoS2JXaBuM

A comprehensive playlist of 'Getting Started with the Micro:bit':
https://www.youtube.com/watch?v=u2u7UJSRuko&list=PLEo0hMrjdofusveMscRFN9FeqKzDBzuXr

You can use the Micro:bit to prototype all or one part of your brainstormed idea. You do not have to create a fully formed, functional, sleek product! But if your idea involves some sort of interaction with the real world, then that part of your idea could be tested with the Micro:bit in addition to whatever other resources you might be able to get ahold of or is available in the classroom or home situation.

As an example, if I were to use the **guiding question** from earlier:

> *How could a Musician and a Botanist work together to create something to help with the UNSDG of Zero Hunger?*

And my brainstormed idea was to create a device that played music based on the quality of the soil being used to grow crops.

I could use the Micro:bit to **connect a soil moisture sensor to the speaker to play different musical phrases** based on how wet or dry the soil was.

*It is not **compulsory** to use the Micro:bit in the creation of prototypes that demonstrate the answers to the students' guiding questions. However, it is a very useful tool that unlocks both technical competences and enhances creative problem solving skills.*

Step 4 - Iteration

There are several possible iterations of the game as explained above, and teachers and mentors are very welcome to develop and use the game in a way that suits their needs and resources.

Below you can find 4 iterations that have been piloted within the Mind Over Matter project and that will be evaluated by the end of 2022.

Face to face piloting:

Methodology	**Expected results**	**Duration**
Idea generation	Several questions developed and one selected and presented to the group.	2-3 hours
Generation of a possible prototype	The question is transformed into several ideas, one idea is selected as best for prototyping and presented to the group.	10 hours
Prototype testing	The idea is transformed into a real prototype that is functional and peers can test after the presentation. Testing of the prototype and its improvement can be implemented many times, depending on the resources and time available.	20 hours

Online piloting:

The purpose of online piloting is to promote STEM among young people living in remote areas in a way that is also possible during the pandemic periods when young people are not able to work in groups face to face.

Remote participants and students may work individually but collaborate online with peers using the same selection of cards to contribute to a group project. The MOM card game can be used online with only slight changes to the approach. For instance:

Brainstorming session - students with mentors	2 hours with a group of students. The session ends with 4 cards per student.
Break for further research - students working individually	3-5 days*. Students investigate cards and generate as many questions as possible. Select one question for the presentation during the next online session.
Micro:bit and other technologies session (how to use equipment) - students with mentors	2 hours in which students present their questions and mentors explain how to use the tools provided to students.
Development of the idea and prototyping with troubleshooting session(s) - students work individually with the possibility of online communication with mentor or peers	5 days in which the students work on the prototype, test and iterate new versions if needed.
Presentation of the results - students with mentors	2 hours in which each student has 10 minutes to present the cards they selected, the driving question they formulated, their idea and functional prototype. Mentors and peers can ask questions and comment on the work presented.

**During this period the participants are sent tools (such as the Micro:bit) via post.*

Online piloting can also function in a blended environment, either with mentors being online and students in groups working together, or both mentors and students being in the groups working together in an online environment. The online piloting can last up to 15 days. Students can be introduced to the equipment they should (or must) use, but also can be instructed to use whatever they have to hand in their own environment.

Step 5 - Presentation and Documenting

The presentation of the project should start with an initial presentation of the team and each member individually. Next, the team members should present the 4 cards they have chosen and the question they have formed using them. This is followed by an explanation of the problem and a presentation of the work process through which they came to the solution of the given problem. Finally, the solution to the problem is presented.

It is important to capture and document the results created by the students in order to reward and validate their efforts and showcase their work, as well as provide examples for students that may undertake this activity at a later stage. Students are encouraged to document their process through photography, diary, selfie videos, etc. and teachers are invited to incorporate that material into their documentation and feedback.

The MOM Project website (**steamproject.eu**) hosts submitted examples of student work from the five participating countries and teachers and mentors are encourage to submit student work to the site.

Teachers register here to receive their log in data. After registration, they log in on this page and then they can upload the student pilots closely following the instructional video in which the whole process is explained in detail.

Methodology improvements developed based on piloting

As a result of the pilots and Makeathons that the MOM development team led, and feedback from both young people and youth workers, the following approaches to the methodology were also found to be helpful for the Extended Version (4 to 5 days):

1) Introduction

Participants begin by introducing themselves, saying what they believe they are good at and can contribute to a group and also nominates an issue that they feel passionate about (accessibility, climate, animal welfare, music education in schools, etc…)

2) Group formation

Participants are allocated a group membership by random numbering to avoid clustering of friends and to reinforce the variety of specialisms and interests.

3) Group roles

One participant in each group is designated by the group as a *Scribe*. Their role is to take notes and record the group's progress. Another participant is designated as the *Timekeeper*. Activities and sprints during the Makeathon/class can be set (eg: For the next 10 minutes, brainstorm… etc.) and the Timekeeper is responsible for ensuring the group stays on track. A third group participant is nominated as the *Spokesperson*. When presentations are made to the entire room, this person speaks on behalf of the group.

4) Card selection

Each group selects a card at random for each category and the Scribe notes the list of cards selected. Students are given 3 minutes to discuss what these cards suggest, the kinds of questions that may arise, and what sorts of projects the group can imagine being made in response to that challenge. This activity is repeated 4 times, and the Scribe should end up with a list of 4 sets of cards from which challenges and guiding questions can be formulated.

Groups are then given 5 minutes to discuss and asked to rank the combinations from easiest to hardest (numbering them 1 to 4) in terms of their perceived level of difficulty to combine the cards and make a good project inspired by that selection. These are shared on a whiteboard for the entire room to discuss and reflect upon (10 minutes).

The youth worker/facilitator then assigns them all a particular ranked set as their challenge to work on. We found that telling the students that they must work on the ‘second hardest’ group of cards

(ranked 3) was accepted by the students as both a challenge and a relief that they were not assigned the hardest set.

5) Initial question formulation

Students are asked to create a question based on the cards that they have been allocated. They should be told that the question only needs to be inspired by those cards and the words in the cards do not all necessarily have to appear in the question. The cards are a thinking tool to open ideas, not a prison that they must endure.

6) Research

Students are asked to spend 30 minutes research the cards that they have. Wikipedia, Google, etc. The group is asked to find information about those terms, roles, and SDGs that they find particularly interesting, surprising, or challenging. The group is asked to collate (and the Scribe to write down) as much information about each of the cards assigned as they possibly can in the time allocated.

7) Word association

Participants are asked to spend 2 minutes per card writing down as many associated words, concepts or ideas that come to mind when they think about the word(s) on the card. For instance, if the word is 'sculpture', they may think of clay, museum, public art, thinker, stone, chisel, build, cut, etc. Students are then asked to include the issue that they said they were passionate about in the initial introduction. They are encouraged to spend another 2 minutes each on these words and concepts to find related concepts and possible points of connection. The purpose of this exercise is to enable the students to think more broadly around the cards that they have been assigned so that the challenges and prototypes that they create may be something that is inspired by the card methodology rather than dictated directly by the words that appear in the cards.

8) Question formulation

Using the cards, the research and the word association with card concepts and student passions, the students are then invited to reformulate their initial question and develop it in a way that reflects a challenge that they are invested in finding a solution to.

9) Mentorship

Each student group is assigned another student group to mentor. For example, Group 1 mentors Group 2, Group 2 mentors Group 3, Group 3 mentors Group 1. 30 minutes is allocated for mentorship during which time the role of the mentoring group is to attempt to question and improve the challenge created by their mentees. Groups are then asked to reflect on whether and how their question might change. Mentorship sessions are then regularly assigned during the program. In

developing this methodology, we found this not only built social connections and improved the quality and ambition of the projects but also fostered a collaborative environment rather than a competitive one, in which all students were keen to help each other succeed to the best of their ability.

10) Inspirational injections

Each morning, students were invited to listen to a guest speaker or video of a presentation that would give them new ideas for their work and explain new ways of thinking about using technology and creativity to address grand societal challenges. Two videos from MTF Labs were examples of this, and we can recommend these as starters (in English), though you may have other suggestions, local guest speakers or other ways of providing inspirational and instructional input that can improve the students' thinking about their projects.

Tom Fox: Sonifying Climate Change
https://www.youtube.com/watch?v=BVMFZijzRUg

Sofia Crespo and Feileacan McCormick: Generating Life
https://www.youtube.com/watch?v=irswkU9R5j8

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Mind over Matter methodology description

Mind over Matter (MOM) is an Erasmus+ strategic partnership project that includes partners from five different EU countries. The objective of the project is to **increase motivation among youth** (13 – 18 years old) to continue their further education in the STEM field (**S**cience, **T**echnology, **E**ngineering, **M**athematics) by creating and implementing an innovative, hands-on, inquiry-based methodology that will demystify science and scientific processes.

The developed methodology relies on (1) an environment conducive to high youth engagement; (2) high investment from the youth in their learning, (3) problem-solving in the context of the real world and (4) planning in a non-traditional format where educator doesn't have a predefined end goal for youth to reach. In addition, youth will be actively engaged in solving the challenges of the World by addressing problems derived from Sustainable Development Goals (SDGs).

We materialized this methodology through the ***Mind Over Matter Game*** and created an endless list of challenges that young people can solve in the form of different educational activities.

By adding the **A**rt pile in the MOM game, we integrated creativity and art to a broad range of scientific disciplines and created an interdisciplinary (STE**A**M) approach that draws knowledge from across a diverse range of expertise. This creative combination allows young people who might not immediately self-identify as a candidate for a STEM pathway to have a positive experience of STEM subjects in the context of something that more readily captures the imagination and is project- and goal-oriented rather than detail-focused inside only one of the STEM fields. This can then lead to a growing interest in a STEM specialism or further work in STEAM-oriented careers.

The design of the MOM project is based on **connecting and empowering young people and youth workers and fostering their engagement in solving real-world problems**. Empowering young people is accomplished by changing their perceptions and biases regarding their own possibilities to have successful STEM or STEAM careers and contributing to the development of society.

The methodology is highly sustainable, the problems proposed in the Mind over matter game can easily be used again at a later stage - even years later - by developing solutions that are designed around new STEM findings. This is simply achieved by adding extra cards (STEM careers/concepts/art/SDGs) or replacing existing cards. Educational methods that are incorporated in the methodology are **based on research findings of the needs of youth and their experience in learning STEM using formal methods**, which many have found disappointing or inaccessible. Therefore, the methodology has high relevance, quality, and efficiency for the challenge-driven development of young people.

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