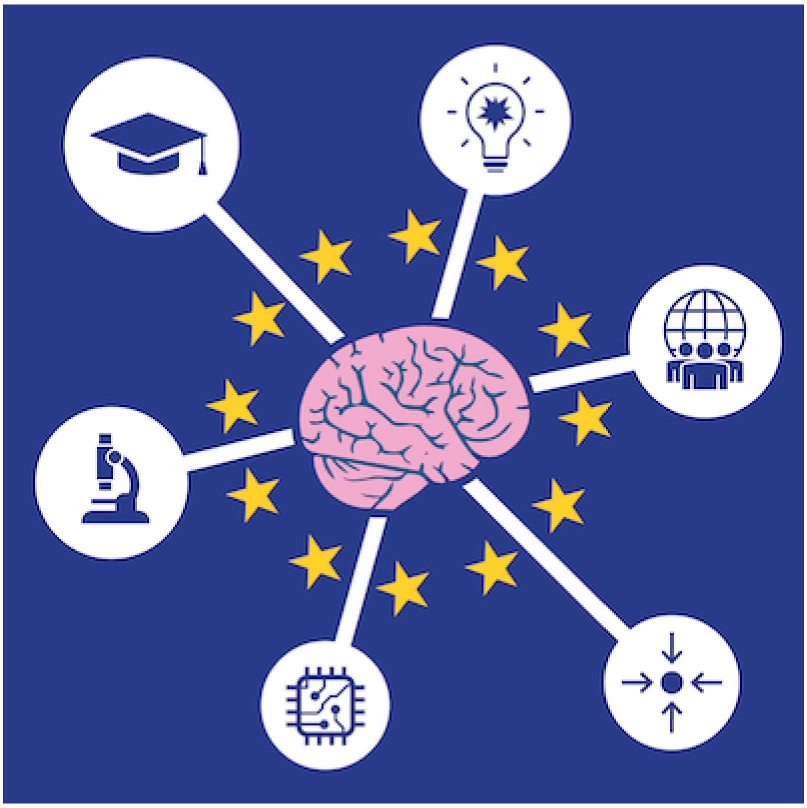
Neurotech^{EU}

The European University of Brain and Technology



[D7.8]
[Dissemination content for STEM fields, 1]

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Executive summary

Middle and high-school years are informative times as students find their interests, which will often be the focus of their studies at the university. Despite the changes in student demography in STEM fields, females still constitute a minority in these programmes. To promote STEM among all students, NeurotechEU plans to disseminate the Alliance's offer via student events (ESU, BrainBee competitions), as part of task D7.5 - Promote (all aspects of) diversity in STEM disciplines of WP7.

In this context, the present deliverable outlines examples of content and methodologies that may be used for promoting STEM education in schools, especially among underrepresented groups in STEM fields. The material will be made freely available in the NeurotechEU portal. This is a living document that will be populated with relevant material from consortium partners.

1. "CREA": An Inquiry-Based Methodology to Teach Robotics to Children

Reference: *Blancas, M., Valero, C., Mura, A., Vouloutsi, V., Verschure, P.F.M.J. (2020). "CREA": An Inquiry-Based Methodology to Teach Robotics to Children. In: Merdan, M., Lepuschitz, W., Koppensteiner, G., Balogh, R., Obdržálek, D. (eds) Robotics in Education. RiE 2019. Advances in Intelligent Systems and Computing, vol 1023. Springer, Cham.*

"CREA": An Inquiry-Based Methodology to Teach Robotics to Children

The Program consists of six sessions (units) lasting one hour and a half each. In the **first session** (Robot Observation, RO), children form groups of two or three people and remain in the same group throughout all sessions. Here, each group is randomly introduced to a robotic platform and is asked to observe it, interact with it, identify its behaviours and write them down in a worksheet. The first session serves as an introduction to the robots and the following sessions guided the students from initial robotic components observations to the programming and construction of the robot. Thus, students are not only presented with a possible outcome (a fully built robot) before engaging in the task, but they also may decompose it in discrete parts and reflect on how these parts work in isolation.

For the **second session** (Identification and Analysis, IA), the aim is to identify the key elements that compose a robot (inputs, outputs, and pins) and to relate them to the components of programming (functions). To do that, students are organized in groups and each group's worksheet is transcribed in a printed version and randomly assigned to another group. Students are then asked to analyze the information on the sheets and to identify and classify the inputs, outputs, functions, variables, and pins (the position of the board where an item is connected) and color-code them similarly to the colors used in Visualino (Fig. 1(2)). Finally, students are asked to relate the inputs with the corresponding functions and outputs (for example: Button -input- ! when pressed, turns on -function- ! LED -output-).

In the **third session** (Paper Blocks, PB), the worksheets generated in the previous session are again randomly distributed to the groups along with a paper version of the blocks used in Visualino to program each robot. Groups must first read the instructions from the worksheets, find the corresponding blocks of Visualino and connect them accordingly, almost like assembling a puzzle (Fig. 1(3)). This session allows students to familiarise with the Visualino blocks and the programming units, without being exposed to the actual interface. At the end of sessions IA and PB, groups receive feedback on their work separately.

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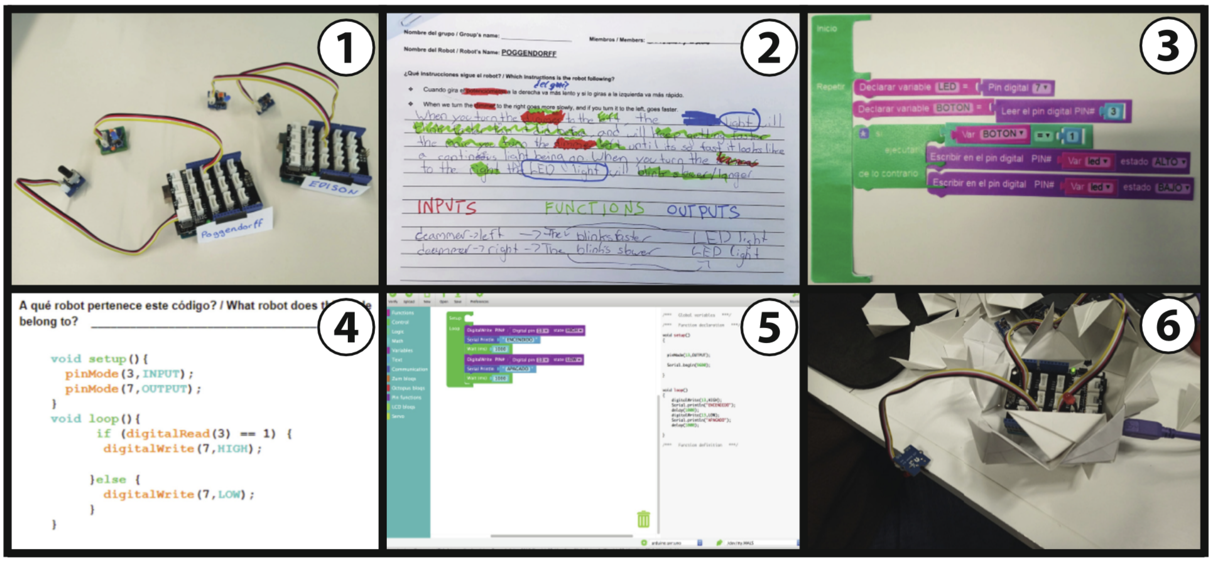
In **session four** (Arduino Pairing, AP), students familiarise with the software interface. The groups are given papers with code in C (Fig. 1(4)) and groups must pair each paper with the corresponding robot. In this way, students are introduced to formal programming and how code is translated into action or behaviour. Afterward, each group is given a random picture of the assignment of PB (an image of Visualino blocks) and were is to translate it into actual Visualino code.

In the **fifth session** (Code in Visualino, CV), each group cooses a robot and decides on a new design and task to be implemented in the robot, by making changes in the Visualino code. This is in agreement with previous work showing that the ability to choose one's project increases the motivation to perform a task [13]. Finally, in the last session (Robot Construction, RC), each group applies what they have learned in the previous sessions to program their proposed robot.



Examples of the six sessions of "CREA". (1) Robot Observation (RO), (2) I Instruction Analysis (IA), (3) Paper Blocks (PB), (4) Arduino Pairing (AP), (5) Code in Visualino (CV), (6) Robot Construction (RC).

2. "Cochlea" Experiment

References: Information: © (Agrawal, 2016) Experiment: © (DiSpezio, 2015)

Introduction

The cochlea is the part of your ear after your oval and round window (Figure 14). It is a long coiled tube and has three tubes inside: the scala tympani, scala media (which contains endolymph) and scala vestibuli. Scala tympani and scala vestibuli both contain a fluid called perilymph. Soundwaves enter the cochlea via the middle ear bone and are further transferred via vibrations in the fluid. Between the scala tympani and scala media are separated via the basilar membrane. This membrane contains a series of fibres of varying lengths, each corresponding to different sound frequencies: long fibres are for low pitches and are near the tip, short fibres are for high pitches and are in the beginning of the cochlea, near the middle ear bone. But how are these fibres "tuned" to respond to different frequencies?

Materials

- Six 1-litre plastic bottles
- Water

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Procedure

1. Find yourself a partner and clean and dry all the plastic bottles
2. Blow into the neck of a 1-litre bottle to produce a sustained tone. What will happen to this note if
   water is added to the bottle?
3. Fill the bottle 1/3 with water and blow again. Is the tone higher or lower than when the bottle was
   empty?
4. Add more water and observe the differences in the sound quality. What happens with the quality when more water is added? What happens to the amount of air within the bottle space as water is added to the container? How does the mass of a vibrating object affect its pitch? Why does adding water to the battle affect the pitch?
5. Let's go deeper: Obtain three 1-litre bottles. Leave one bottle empty, fill one 1-liter bottle 1/3 full with water, the second 2/3 full of water and position these side-by-side on a desk. Select a fourth 1-liter bottle as the "master" tone maker
6. Have your partner put his/her ear close to the necks of the three stationary bottles. From a distance of a few feet (approx. .5 to 1 metre), blow into the master bottle to produce a steady tone. Then stop
7. Have your partner note in which stationary bottle the sound continues to ring loudest.
8. Fill the "master" bottle with 1/3 of water and repeat steps 6 and 7. Do this again using a master bottle that is 2/3 full of water.
9. Which container continues to ring after the empty master is sounded? And after the 1/3 full master bottle is sounded? And 2/3? What relationship can you infer from these observations?
10. What about the cochlea? Discuss the following questions with your partner: what causes the central filament with the cochlea to vibrate? How is the basilar membrane adapted to distinguish pitches? What caused the target container to produce the sound of the master tone maker? Why didn't all the containers respond to the master sound tone? How is the tuning of the basilar membrane and the water-filled containers similar?

Explanation

The pitch goes up when more water is added. When more water is added in the bottle space, the amount of air is decreased. And the bigger the mass, the lower the pitch (think of a small dog with high pitch, and a big dog, with a low pitch). As water is added, the pitch goes up because the size of the vibrating air mass has decreased. Also, containers will vibrate "in-sync" if they contain the same amount of water as the master tone maker.

Now back to the cochlea: Vibrations within the surrounding fluid causes the central filament with the cochlea to vibrate. The basilar membrane has a series of fibres with varying lengths and each length responds to a specific frequency, like only the bottle with the same amount of air corresponds to the master bottle. The vibrations of the master tone maker travelled through air and struck the container using it to vibrate. So, objects or regions will vibrate only if they are "in tune" or "in sync" to the surrounding waves.

Expand

Use a piano or portable keyboard as a guide for creating a set of plastic bottles that will correspond to the notes of the musical scale. Work in a group, using the set of plastic bottles to produce a musical composition that includes all of the notes.

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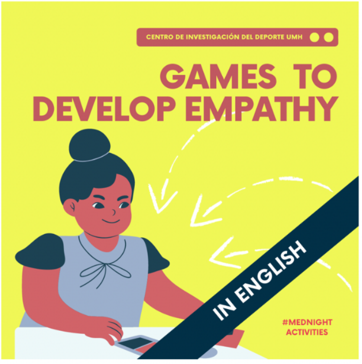
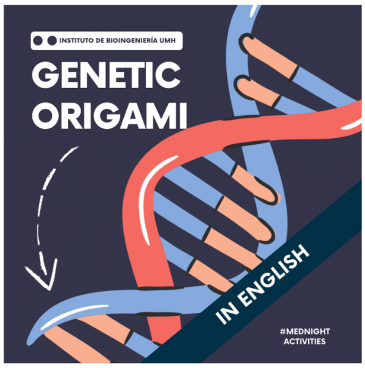
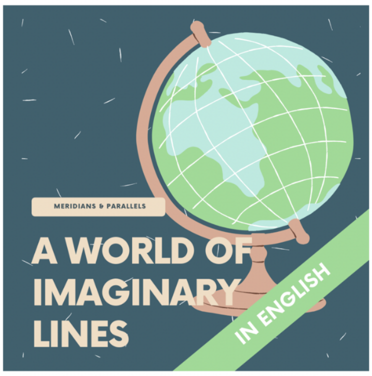
3. UMH Science at Home

Link to content: https://umhsapiens.com/science-at-home/

Dissemination content **Pre-K to 5th Grade/Early Years to Key Stage 2**







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Dissemination content **6th Grade to 9th Grade / Key Stage 2 to Key Stage 4**