CoALA-Code a Little Animal

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<Info>

<Keywords> simulation, IPO model (input-processing-output), measurement, computational thinking, making

<Disciplines> science, biology, computer science

<Age level of the students> 9–13

<Hardware> Calliope mini[1] or BBC micro:bit[2]
<Workshop A> crocodile clips, red craft plastic, USB cable and battery for the Calliope mini, self-adhesive copper tape (5 mm), cardboard, glue, scissors, small water glass, poster with animal pictures
<Workshop B> crocodile clips, USB cable and battery for the Calliope mini, Grove moisture sensor, Grove I2C touch sensor, Grove NFC, Grove I2C hub[3], cardboard, red craft plastic, small water glass, poster with animal pictures

<Language> MakeCode[4]

<Programming level> easy

<Summary>

You would be hard-pressed to find a child who does not want to own a pet. To find out which one is the best, the students will construct a simulator that is controlled by a single-board computer and uses external sensors to imitate the needs of a pet.

<Conceptual introduction>

The subject of 'pets' is not only part of the curriculum in primary schools but also in secondary schools in biology, where students learn how dogs were bred from wolves, the basic needs of a pet and the requirements that owners need to meet. Typically, students analyse texts in their schoolbook or videos on the Internet because schools cannot easily provide pets for this purpose. Therefore, an electronic simulator to depict the basic needs of a pet (food, drink, exercise, petting and correct body temperature) would be both illustrative and instructive.

The CoALA project does not utilise ready-to-use devices from commercial teaching material manufacturers that only allow specific, limited programs provided by the manufacturer. Nor is a simple toy used, such as the Tamagotchi, which was a worldwide success in the 1990s. Instead, the students plan, construct and program their own simulator in the form of their favourite pet, including an image of the animal, with the aid of a single-board computer (in our case, a Calliope mini[1] or a BBC micro:bit [2]) and craft supplies such as cardboard, copper tape, and external sensors. The students program an algorithm to record and evaluate the basic needs of the chosen animal. Depending on the algorithm, the animal simulator shows different smileys (to show how the animal feels) or plays fitting self-composed melodies.

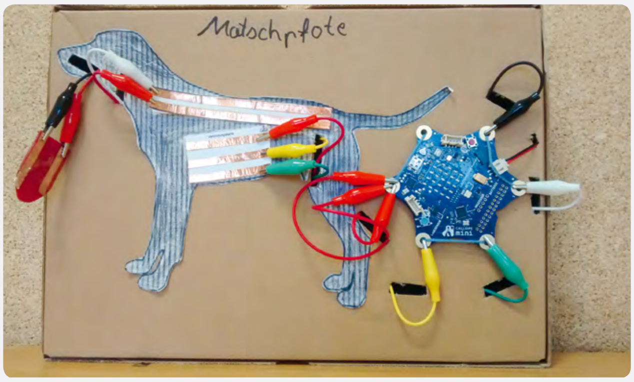
The concept of the project 'CoALA—Code a Little Animal' is that of a workshop. The OER (Open Educational Resources) teaching materials consist of three parts. The first part introduces the students to the basics of algorithms and handling the Calliope mini single-board computer[1]. In part two, they explore the basic needs of a pet and how to assess them. In part three of the workshop, the students build their favourite pet with cardboard, install the single-board computer and the appropriate sensors and create suitable algorithms with the aid of a graphical programming language.

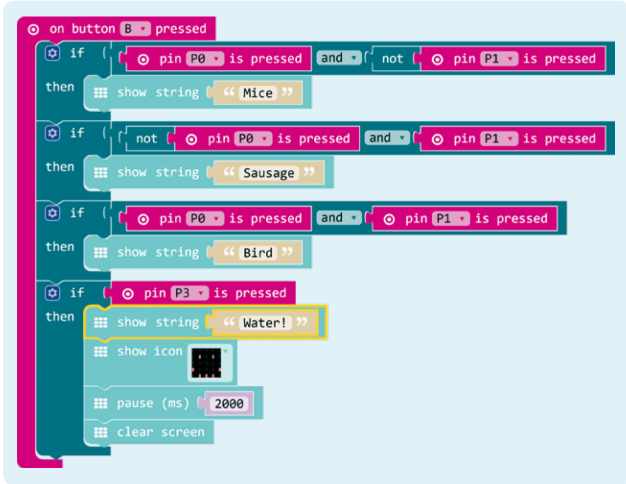
To meet the requirements of the science curriculum in primary schools and the biology curriculum in secondary schools, we offer the workshop materials in two versions. For primary schools (workshop A), the rates of eating, drinking and petting are measured and recorded by using conductive, adhesive copper tape. For secondary schools (workshop B), the students use external sensors to measure moisture (drinking), for multi-touch interactions (petting) and for the wireless read-out of Near Field Communication chips (eating). In both versions, built-in sensors measure movement and temperature.

All the workshop materials plus coding examples for the programming environment MakeCode[4] are available for download online.[5]

<What the students/teachers do>

To build the pet simulator, the students look for an image of their favourite pet or take a picture themselves. The printed image is glued onto the cardboard and equipped with adhesive copper tape (workshop A) or external sensors (workshop B) in the appropriate places. The adhesive copper tape or the external sensors is/are wired to the connections of the single-board computer and a suitable program is written on the computer to make it 'intelligent'. In the following example, the basic need 'food' is used to explain how the two versions of the workshop differ and how the programming environment is used.

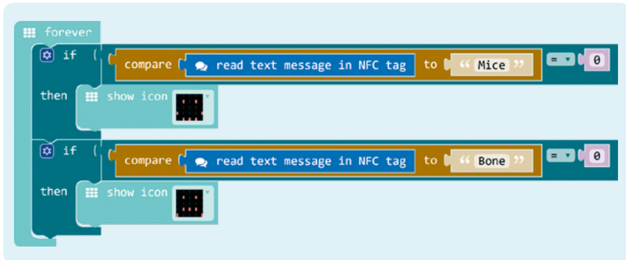




When the simulated pet feeds, taste sensors obviously cannot be used. Instead, the appropriate sensor 'reads' the offered food and the algorithm is controlled by a suitable conditional branch so that the output corresponds to the expected behaviour of the pet. Therefore, the display of the cat simulator shows a smiley (face) when it is fed a mouse and a sad face when it receives a bone. These branches are the same for both versions of the workshop.

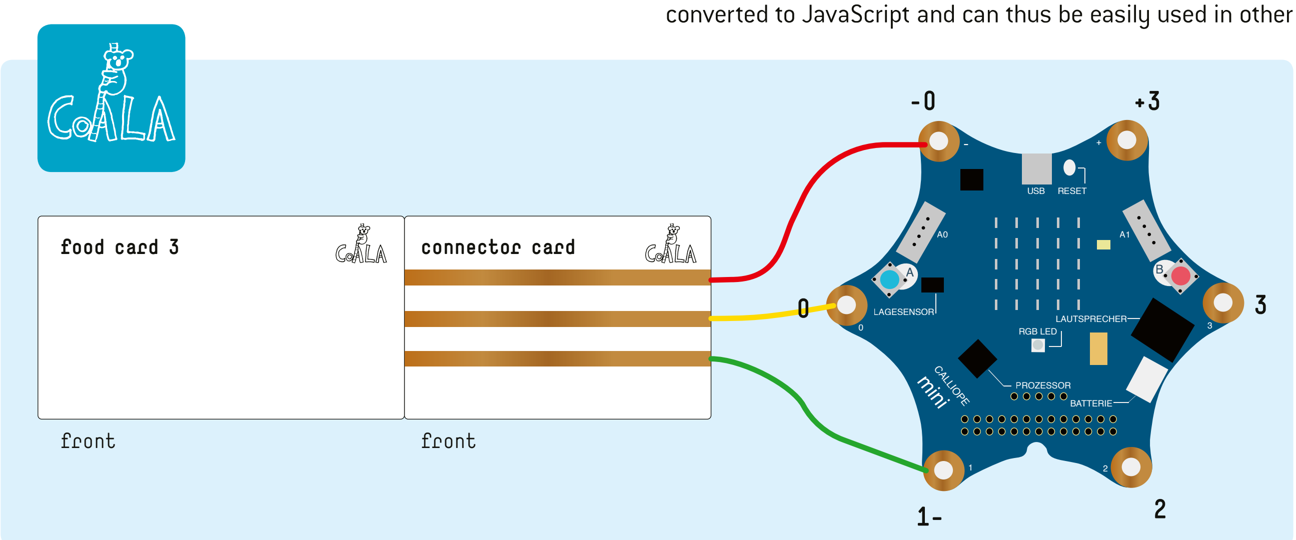
However, the food sensors are completely different. In workshop A, pictures of different kinds of food are fastened to cardboard cards. On the other side, copper tape is glued to those cards so that the 'tongue' of the simulator 'reads' a binary coded number when the card is held to it. As the connections of the 'reader', i.e. 'tongue', are connected to the different pins of the single-board computer, the algorithm can test directly whether the pins are short-circuited or not: the food cards short-circuit different combinations of pins.

In workshop B, an external sensor with an NFC chip and attached radio antenna is used to wirelessly read out strings from an NFC tag. This tag can either be on an adhesive label or in a chip card. Unlike in workshop A, no binary coded number is read out, but instead the name of a food like 'fish' or 'bone'. This increases the implementation options and the complexity significantly. In the algorithm, the conditional branch is controlled by comparing the read-out value with the strings provided. In the CoALA project, the NFC tags are written on via a smartphone app; the read-out of the NFC tag is didactically reduced to a single block of code in MakeCode[4] and then loaded as an extension of the programming environment.



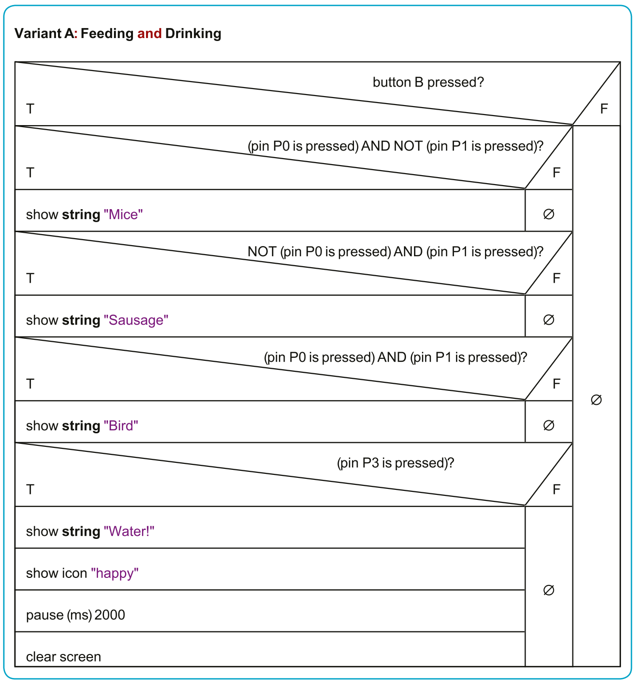
<Algorithm to use in other languages>

The available code examples[5] can be uploaded to the online MakeCode programming editor[4] and then used directly. By switching from block view to text view, the source code is converted to JavaScript and can thus be easily used in other



programming languages for the Calliope mini[1] or the BBC micro:bit[2]. The programming extensions for MakeCode used in the workshop materials to control the multitouch and NFC sensors also work for the BBC micro:bit.

Lastly, the programming examples are provided on the website as structure charts so the algorithms can be easily understood and ported to other platforms and programming environments such as Arduino.



<Conclusion>

The CoALA project provides students with the opportunity to familiarise themselves with the fundamental concepts of algorithmics—statements, sequences, conditional branching, loops and variables. They do not learn them by simple memorisation and reproduction but rather by working on an exciting educational project with real-life applicability. They use simple materials to construct a personal pet simulator, which they bring to life with the help of coding and their own imagination. The workshop materials provided teach computer science skills in a didactically reduced form and at the same time offer different levels of learning, thus meeting the needs of heterogeneous learning groups or older students. Both versions of the workshop can be easily mixed.

The workshop materials have been successfully tested with a Calliope mini[1] and the single-board computer BBC micro:bit[2]. A low cost extension board is needed to use the external grove sensors for moisture measurements, for NFC or for multitouch in workshop B with the BBC micro:bit.[3]

<Cooperation activity>

The CoALA workshop can be used in various forms of cooperation. As the material is for primary schools as well as for secondary schools, an exchange could take place between different types of schools. Thus, the exchange would not only be rewarding for the students but also for the teachers of both types of schools. The materials of workshop A are designed to teach simple logical Yes/No differentiations, while the materials of workshop B are designed to teach more complex, combined conditions, variables and string operations.

The materials of the workshops can also be combined as needed to promote cooperation within heterogeneous learning groups. Students who need more support could, for example, use the simple sensors of workshop A, while stronger students could explain the sensors of workshop B to their classmates and practise their communication skills in the process.

During the CoALA project, transnational cooperation between two secondary schools took place in which two groups of students—one from Germany and one from Spain—discussed their experiences with pet simulators via video conference. In addition to suggestions for problem-solving, the vocabulary of names and basic needs of their pets were exchanged in English as well as in their respective native languages—coding in STEM education with a language course.

<References>

[1] https://calliope.cc/en
[2] www.microbit.co.uk/home
[3] If you use a BBC micro:bit, you also need a Grove Shield for micro:bit.
[4] https://makecode.calliope.cc/?lang=en or https://makecode.microbit.org/?lang=en
[5] All additional materials are available at www.science-on-stage.de/coding-materials.

<Imprint>

<Taken from>

Coding in STEM Education
www.science-on-stage.eu/coding

<Published by>

Science on Stage Deutschland e.V.
Am Borsigturm 15
13507 Berlin, Germany

<Revision and Translation>

Translation-Probst AG

<Design>

WEBERSUPIRAN.berlin

<Illustration>

Rupert Tacke, Tricom Kommunikation und Verlag GmbH

<Credits>

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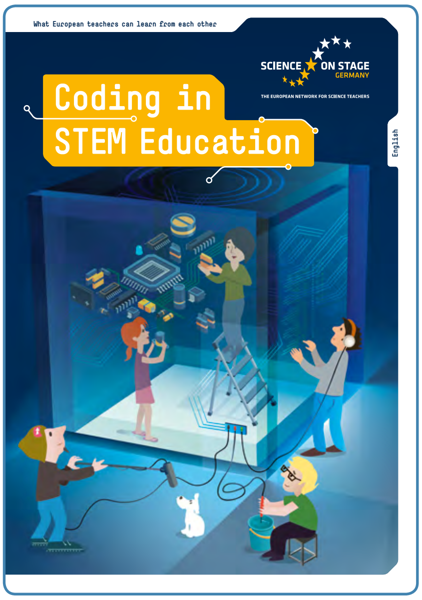
<ISBN PDF>

978-3-942524-58-2

First edition published in 2019



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