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Research Article

Proposed use of TinkerCad in primary school computer science classes to support Arduino programming

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Abstract – Nowadays, there is a strong emphasis on practical teaching, on teaching with the possibility of using what has been learned in the home environment or in leisure activities. This also requires the use of modern educational methods and, above all, modern teaching aids. This includes the TinkerCad environment accessible via a web interface. It allows not only full-fledged simulation but also the creation of your own program whether with deeper programming knowledge or just basic. Its great advantage is that it is freely accessible and without any large financial outlay spent on buying an Arduino board or other electronic components, it allows you to develop your own simpler and more complex projects. These can also be developed by pupils in teams, thus encouraging pupils to work collectively. Last but not least, we can also mention that using the simulation environment does not risk damaging the equipment and there is no risk of electric shock. Many pupils are very lively and interested in many things, and they can also accidentally damage equipment. In our work, we will focus on the design of such a project, where the Arduino calculates the product and sum from the two variables loaded. This will teach students how to use Arduino, LCD display, serial port with the aim of course to promote algorithmic thinking and increase interest in science among students. By managing all this without programming in a commonly used programming environment, it allows us to use this example in the upper primary school years, where pupils can use their existing knowledge creatively.

Keywords –Computer Science, Education, TinkerCad, Arduino, Programing

I. Introduction

Nowadays, we can enjoy a great boom of Arduino boards. In addition to achieving educational goals, it enables a wide range of applications in various areas of social life - in applied form, of course. We can mention its applications as a HW and SW component, for example, in robotics, automotive industry but also in agriculture for irrigation control or as part of a UAV, which allows its use in the field of mapping the earth's surface, preservation of cultural heritage or automation of other activities. [1-4] [8-10] Certainly, teaching Arduino in primary schools is difficult to imagine, if only from the point of view that pupils do not have sufficient knowledge of electronics and programming languages. This barrier is overcome by TinkerCad, which can be used to program an Arduino board in an iconic environment with which pupils already have experience - for example, they have already encountered Scratch. 5] [6] [7] [8] In addition, in TinkerCad we can use a full simulation environment where there is no risk of damage to the device by careless actions of the pupils. Moreover, in a playful but mainly innovative way, we can also motivate pupils and encourage algorithmic thinking. In [11-16] we focus in our paper on the possibility of using TinkerCad in primary school computer science classes. The benefits are the promotion of creative thinking, the acquisition of ICT competences and working in a team. [17-23]

II. Materials and Method

At the outset, we must mention that the use of Tinkercad has some specifics that are mainly related to the use of the environment. We are specifically referring, for example, to how to run the simulation, how to use the individual components, etc. We will not deal with this area but we will show specific steps and procedures. In figure number one we see the TinkerCad environment itself with the basic components:

- Arduino – Arduino Uno R3,
- small breadboard and
- two-line LCD display with 16 display characters per line operating under I2C communication standard (32 bit address).

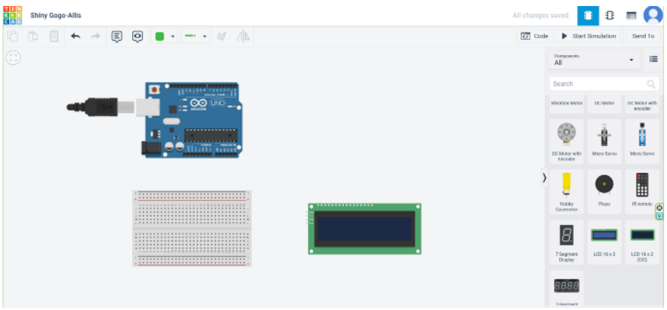

Fig. 1 TinkerCad environment

In the first step, we need to connect the LCD display and the Arduino board. We also need to configure the I2C protocol to communicate with the LCD display. We show the actual wiring and configuration in figure 2. Let's label the LCD "1". In practice, we can encounter two types of expanders: the MCP23008 or the PCF8574. Also in our example we have to choose the correct type. In figure number 2, the red arrow points this out.

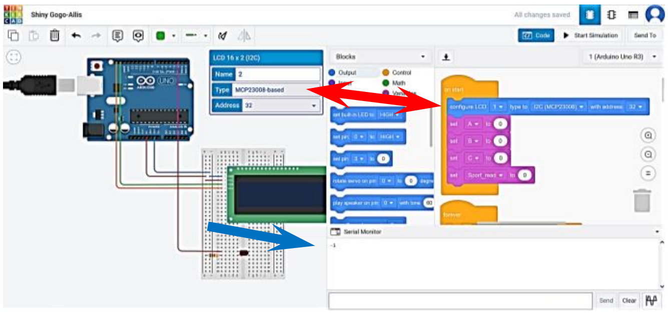

Fig. 2 Configuring the LCD display and showing the location of the serial port

We can see that we also have an LED connected. We can use this to signal during testing, for example, or we can use it for other custom purposes. We can also see in the aforementioned picture that we have created four variables beforehand. We will use these to continuously read the serial port (Sport_read), to read two numbers from the serial port (variable A and variable B), and to store the results of the calculations before outputting them to the LCD and serial port (variable C). Again, we would like to reiterate that we are using only iconic programming and are focusing on the principle of operation not the details of the programming. Therefore, we do not even show the code in the programming language - because we do not create code for this example in any programming language either, only in a block environment. This brings with it some complications that we will have to deal with in our next activity - namely integer/string conversion.

The blue arrow in the above figure indicates the Serial port. We will use this for inputting numbers but also for outputting results. After entering two integers, we will sequentially calculate two values: C = A + B and C = A * B. We print these results on the second line of the LCD display in the following form: result 1 ==//== result 2.

We can notice that when we do not enter any value through the serial port and read data from this port, we get the value -1. We will use this in our problem as an if condition.

III. RESULTS

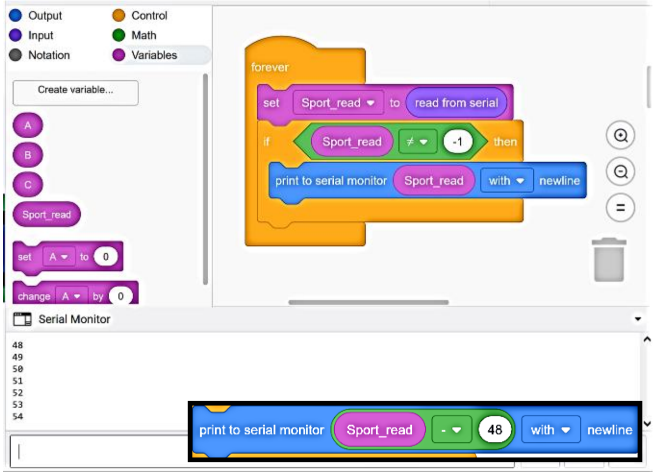

Fig. 3 Read and re-write to the serial port. On the bottom right, modified writeback reduced by 48

Once configured, we can proceed to testing. Preliminarily, we can test the serial port functionality with the students by simply writing the read value back to the serial port. We show the configuration of the blocks used in Figure 3. We can already see at a glance that a simple test will work, but when we enter a number, e.g. 0, the number returned is 48. This is due to the string/integer processing (the problem we mentioned above). Since we can't choose to read text or numbers in blocks, we need to either already know or explain the ASCII table at this point.

- The challenge for students may be to solve this first problem, which will guide them on how to work with variables and understand algorithmization. At the simplest level, the solution is to subtract 48 from the value received before listing it again.

Read and re-dump on the serial port. Bottom right, modified reversing the input numbers into two variables, A and B, calculating the sum and product, storing in variable C, and outputting to the serial monitor. The block sequence is shown in figure 4 below.

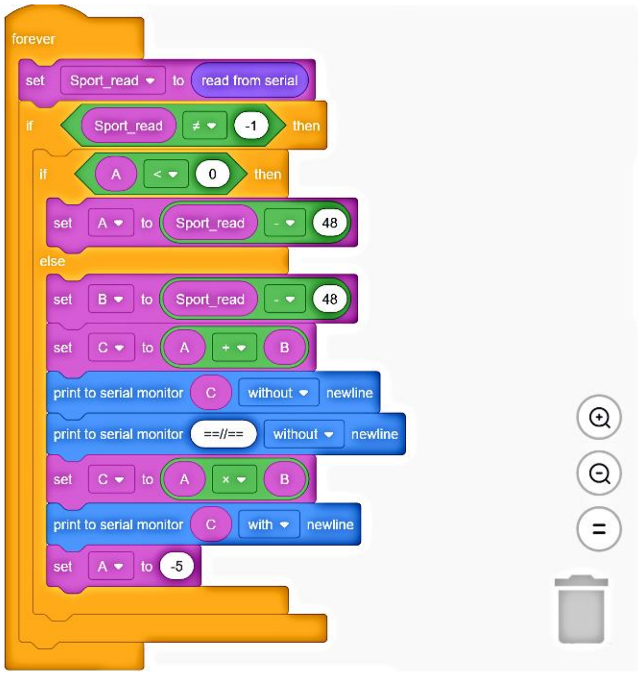

Fig. 4 Listing and calculation of values on the serial port. For the values: 4 and 5; 5 and 6; 1 and 2 we get: 9 ==//== 20; 11 ==//== 30; 3 ==//== 2

- The natural problem will be when we have to solve the problem of when to load into variable A and when to load into variable B. This can be a second assignment for students to solve. For example, the solution may be that variable A will be used for this decision condition. But this entails modifying the existing program. The variable A will no longer be allowed to have a value of 0 when zeroed but a negative value, e.g. -5. This case is already incorporated and presented in the solution presented in Figure 3.

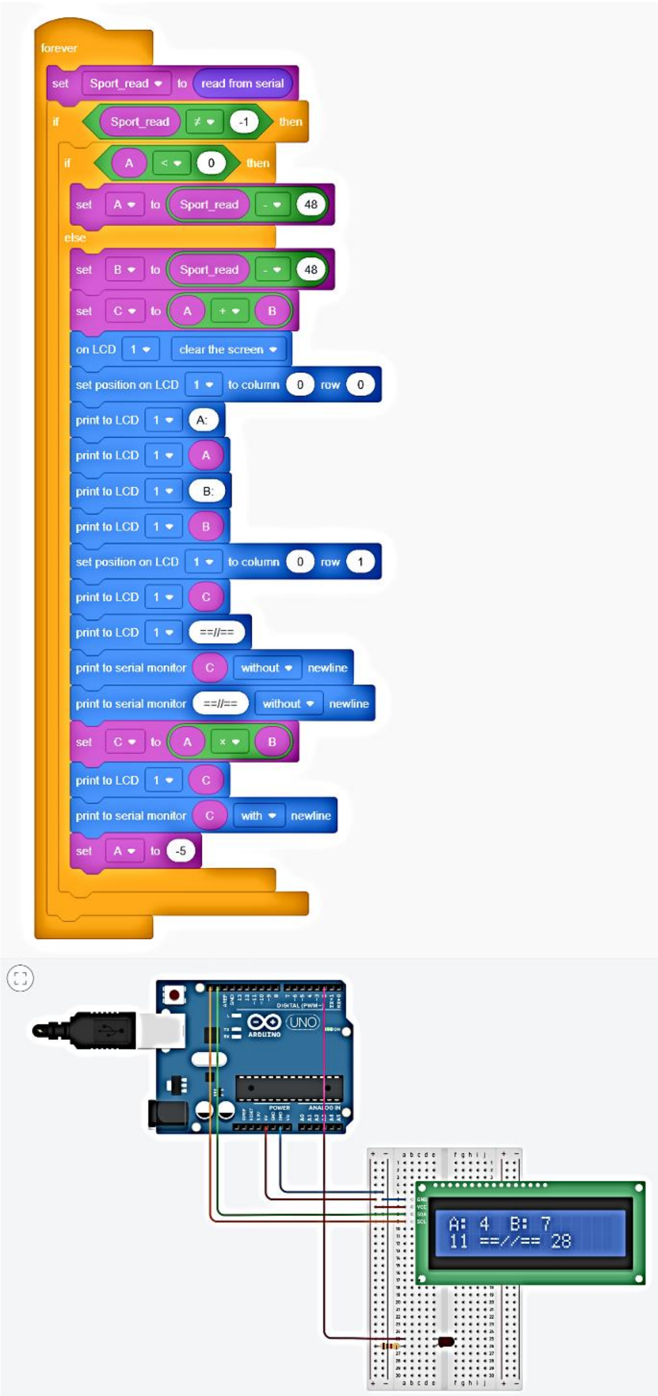

Fig. 5 Hore: complete solution of the example, below: sample activity

Finally, we just need to complete our example so that the output to the LCD monitor works. We have to remind that we have to reset the LCD before we can dump it to the LCD display - LCD clear. We show the entire block sequence in Figure 5.

TinkerCad offers one more clever feature - it can also generate an electronic schematic from our design. This feature can be beneficial in upper elementary school or vocational high school. The flowchart from our example can be seen in Figure number 6.

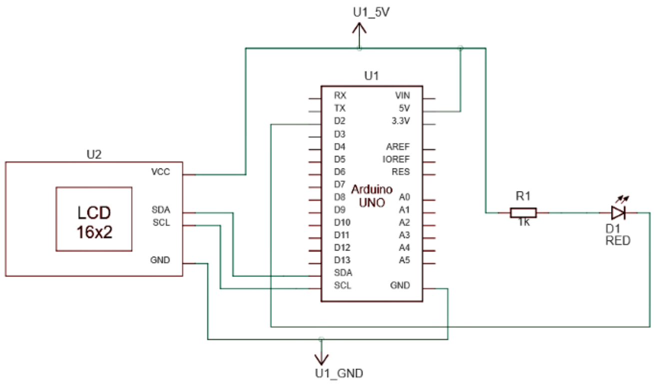

Fig. 6 Hore: Circuit diagram

IV. CONCLUSION

In conclusion, we can argue that the example also combines several areas of programming - sequence, branching, variables, etc. We are of the opinion that the way we have designed to present the material, where certain problems have to be overcome, allows for the acquisition of algorithmic thinking and by making it necessary to solve not simple problems (string/integer conversion, retrieval of variables A and B, etc.), we are able to foster creative thinking as well. It also opens up space for group work and thus fostering a relationship of responsibility.

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