BG Pulse Journal USA
ISSN:1947-2536 http://www.bgpulseusa.com/index.php/bg

UDK: 37.012.8

TEACHING THE BASICS OF ROBOTICS TO STUDENTS (USING THE ARDUINO PLATFORM AS AN EXAMPLE)

Sotvoldiyev Elmurodjon Abdumannonovich
Senior Lecturer at the Department of Technological Education and Library Science, Kokand State University
asadalp3312@gmail.com.
Tel: +998912043394
ORCID:0009-0006-8431-4032

Abstract: This article discusses ways to achieve learning efficiency in teaching the basics of robotics to general secondary school students. This is achieved by utilizing the "simple-to-complex" principle and consequently reducing the "cognitive load" imposed on the student.

Keywords: robotics, practical exercise, simple-to-complex principle, cognitive load, assimilation, intrinsic load, extrinsic load, efficiency.

INTRODUCTION

In today's rapidly evolving technological era, robotics is being widely implemented across all sectors of the national economy. Furthermore, the integration of Artificial Intelligence (AI) into robotic systems is substantially expanding their capabilities. Within the educational framework, a considerable amount of scientific research is also being conducted on the utilization of robotics and robotic systems, as well as on methods for teaching them to students. In particular, STEAM (Science, Technology, Engineering, Arts, Mathematics) education is increasingly becoming a primary vehicle for fostering critical thinking, creativity, and problem-solving skills among students. Robotics lies at the very heart of this educational framework, offering students extensive opportunities to apply theoretical knowledge in practice. In general secondary schools, robotics activities are organized based on the "Arduino" platform. Due to its open-source nature, affordability, and flexibility, the Arduino platform stands as one of the most accessible and effective tools for teaching robotics in school education.

However, experience indicates that during the process of teaching robotics, students often lose interest or encounter misunderstandings when faced with technical complexities. Initially, students engage in the learning process with high enthusiasm and motivation. Nevertheless, when transitioning to slightly more complex tasks, their interest begins to wane if their efforts do not yield immediate results. As a solution to this problem, implementing the "simple-to-complex" principle in education is of paramount importance. This principle entails organizing the educational process and assignments in a step-by-step manner—systematically guiding students from basic logical circuits to complex automated systems. This article highlights methodological recommendations on how to logically and sequentially develop students' skills utilizing the Arduino platform.

LITERATURE REVIEW AND METHODS

The education of robotics and its integration into school curricula have been extensively studied by numerous foreign and local scholars. In particular, the constructivism theory of J. Piaget

and L. Vygotsky serves as the methodological foundation for robotics education. They emphasized that the learning process is significantly more effective when students acquire knowledge through creating physical objects with their own hands (learning by doing).

Research on the Arduino platform and its role in education demonstrates that it possesses "low floor" (gentle introduction) and "high ceiling" (limitless possibilities) characteristics for developing programming and logical thinking skills in students. Researchers such as M. Resnick have advanced concepts akin to the "learning pyramid" in education, according to which the skill of working with foundational components (sensors and actuators) must be consolidated before moving on to complex systems (robots).

While S.S. Alikulov, an Associate Professor at Jizzakh PI, in his article "Learning the Basics of Robotics in General Secondary Schools," and M.Sh. Tukhliyev, in "The Basics of Robotics and Its Application in School Education," highlighted general aspects of teaching robotics, scholars such as H.E. Majidova, Sh.U. Quvodiqova, and D.R. Kholkhojayeva investigated the development of students' creative abilities through robotics. Furthermore, G. Boronova and Z. Adizova provided recommendations on utilizing the Arduino software within extracurricular robotics clubs.

Although there is a sufficient volume of textbooks, methodological guides, and articles on robotics within the scope of local pedagogy and technical education, the majority of them are either confined to theoretical insights or geared toward projects that are overly complex relative to the students' age. In pedagogical practice, systemizing a step-by-step algorithm based on the "simple-to-complex" principle (ranging from lighting an LED to constructing an autonomous robot) through the case of Arduino, and evaluating its impact on students' level of mastery, remains a highly relevant scientific and pedagogical challenge. This article precisely aims to bridge this gap and establish concrete methodological steps for educators.

RESULTS AND DISCUSSION

The initial phase is a period dedicated to awakening the student's interest in robotics and overcoming their "fear" of technical complexities. At this stage, the primary objective is to provide the student with a sense of immediate gratification and to keep the cognitive load at a minimal level.

Pedagogical Approach (From the Perspective of Cognitive Load)

- **Intrinsic Load:** Extremely low. The student interacts with only 4 components: the Arduino board, a breadboard, an LED (Light Emitting Diode), and a resistor.
- **Extrinsic Load:** Minimal. The connection diagram is clear and logical. The code is very concise (comprising only a few lines), allowing the student to focus entirely on the core logic of coding.
- **Objective:** To instill confidence in the student, fostering a "I can do this!" mindset.

Let us now examine the sequence for executing this practical task.

Task 1. Connecting an LED to the Arduino Board. First, we present the connection diagram to the students. This wiring schematic is highly straightforward and is illustrated in Figure 1. Next, we write the code (sketch) for this circuit.

```
void setup(){

  pinMode (13,OUTPUT);
 }
   void loop(){
digitalWrite (13,1);
delay (1000);
```

```
digitalWrite (13,0);
delay (500);
}
```

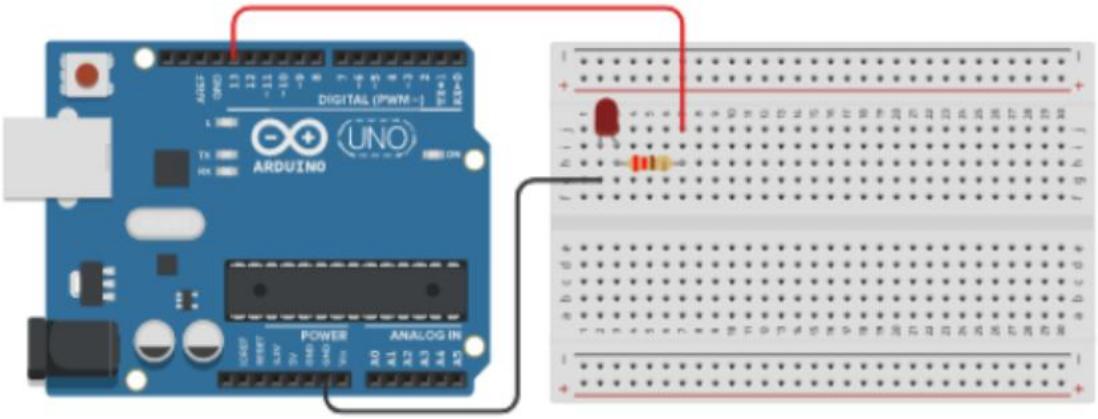


Figure 1. LED connection diagram

We upload the code to the Arduino. As a result, the LED connected to pin 13 will turn on for 1 second and turn off for 0.5 seconds (it will blink).

Task 2. We will increase the complexity of Task 1 slightly. Now, we connect 2 LEDs. For the second diode, it is recommended to select a yellow LED. In doing so, we utilize the diagram from Task 1 as a foundation. The code for this task is as follows:

```
void setup(){
  pinMode (13,OUTPUT);
  pinMode (11,OUTPUT);
 }
   void loop(){
digitalWrite (13,1);
delay (1000);
digitalWrite (13,0);
delay (500);
digitalWrite (11,1);
delay (1000);
digitalWrite (11,0);
delay (500);
}
```

We have simply added a few lines to the code provided in Task 1 (highlighted in red). As a result, we obtain a flashing (red and yellow) light sequence.

Task 3. We will add one more LED (green) to the circuit completed in Task 2 (Figure 2).

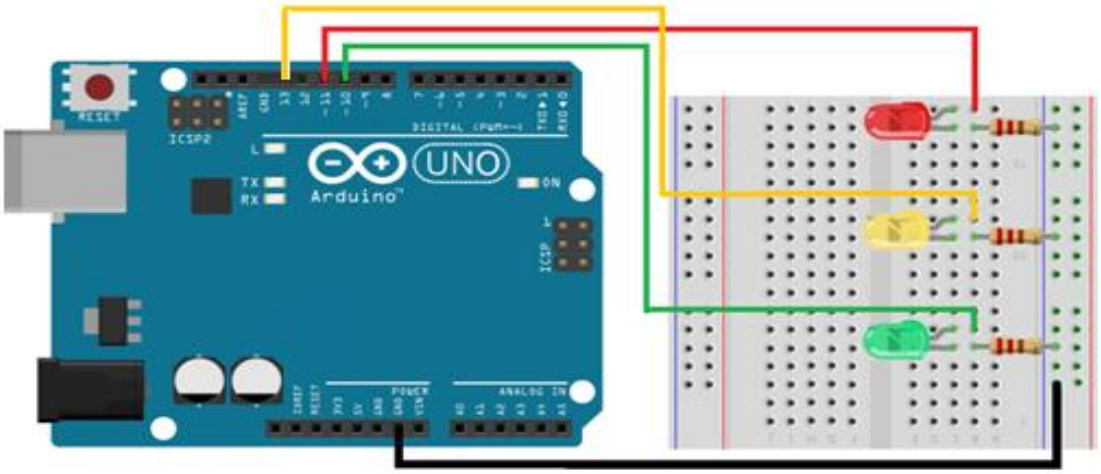


Figure 2. Traffic light LED connection diagram

We will write the code for this circuit utilizing the code from Task 2 as a base.

```
void setup(){
  pinMode (13,OUTPUT);
  pinMode (11,OUTPUT);
  pinMode (10,OUTPUT);
 }
   void loop(){
digitalWrite (13,1);
delay (1000);
digitalWrite (13,0);
delay (500);
digitalWrite (11,1);
delay (1000);
digitalWrite (11,0);
delay (500);
digitalWrite (10,1);
delay (1000);
digitalWrite (10,0);
delay (500);
}
```

Once again, we have simply added a few lines to the code provided in Task 2 (highlighted in red). As a result, we have successfully developed a functional traffic light model.

CONCLUSION

In conclusion, utilizing the "simple-to-complex" principle in the process of teaching robotics to students yields the following significant outcomes:

- **Rapid Comprehension and Mastery:** Students quickly grasp and assimilate the assigned tasks. Experiments demonstrated that the initial simple tasks were fully mastered by the students. Consequently, they were able to effectively apply these acquired insights and skills during subsequent, more advanced assignments.

- **Enhanced Self-Confidence:** The approach instills a strong sense of self-confidence in students. They consistently arrived at positive mindsets, such as "I can do this," "I can succeed," and "This is easy to achieve."
- **High Motivation and Engagement:** Students approach and complete the given assignments with immense enthusiasm and genuine interest.

By gradually increasing the difficulty level of the assignments, students experience a minimal cognitive load. This, in turn, enables them to tackle more complex tasks with ease in the future.

In general, robotics is a relatively sophisticated field that demands a comprehensive understanding of multiple disciplines and their subfields. Consequently, robotics-related assignments initially appear daunting to students. However, if the tasks are tailored to the students' age and structurally selected based on the "simple-to-complex" principle, high educational efficiency can be achieved by minimizing the cognitive load imposed on the learner.

REFERENCES

1. Karimov, B. Kh., Otajonov, S. M., Tukhtasinov, M., & Yunusov, N. (2020). Robototexnika asoslari [Basics of robotics: Study guide]. Fergana: Fergana State University.
2. Sharipov, Sh. S., Qoysinov, O. A., Tokhirov, O. O., Abdullayeva, Q. M., Nasrullayeva, F. A., & Madaipov, A. A. (2021). Texnologiya: 6-sinf uchun darslik [Technology: Textbook for the 6th grade]. Tashkent: Republican Education Center.
3. Sharipov, Sh. S., Qoysinov, O. A., Mamatov, D. N., Tokhirov, O. O., Bozorov, U. A., Nasrullayeva, F. A., Mirakhmedova, D. S., Alovddinova, N. M., & Madaipov, A. A. (2022). Texnologiya: 7-sinf uchun darslik [Technology: Textbook for the 7th grade]. Tashkent: Republican Education Center.
4. Sotvoldiyev, E. A. (2023). Elektrotexnika, elektronika va elektryuritmalar [Electrical engineering, electronics, and electric drives: Study guide]. Kokand: Kokand State University.
5. Boronova, G., & Adizova, Z. (2021). Umumiy o‘rta ta'lim maktablari robototexnika to‘garaklarida Arduino-uno dasturidan foydalanish [Using the Arduino-Uno software in robotics clubs of general secondary schools]. Pedagogik Mahorat [Pedagogical Skills Journal], Special Issue, Bukhara.
6. Majidova, Kh. E., Zuvondiqova, Sh. U., & Kholkhojayeva, D. R. (2023). Robototexnika asosida o’quvchilar ijodkorlik qobiliyatlarini rivojlantirish [Developing students' creative abilities through robotics]. Pedagogika va Psixologiyada Innovatsiyalar [Innovations in Pedagogy and Psychology]. Retrieved from http://ppmedu.jdpu.uz/