

MANAGEMENT OF A DANCE WITH PHOTON ROBOT

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Abstract— Examples of the application of STEM/STEAM activities and new technologies in education are discussed. Some dance programming options with the Photon Coding mobile app to work with a Photon Robot are presented. The steps for working with the individual levels on the topic under consideration are described. Ways to set up basic buttons and blocks in the specific levels are shown. Some of the results of students working with programming software for the first time, and specifically with the Photon Coding mobile application, are presented.

Keywords—art, coding, dance, digital competence, robot, STEM, STEAM

I. INTRODUCTION

The professions of the future, using new technologies, are included in numerous development strategies and policies in our country and internationally. The three main areas of development in the Concept for Digital Transformation of Bulgarian Industry (Industry 4.0) include key technologies such as simulations; autonomous robots; augmented and virtual reality and others. For their implementation, the use of technological solutions such as machine self-learning is specified; artificial intelligence (AI); smart mobile apps and more. [7]. According to the Digital Transformation of Bulgaria for the period 2020-2030, maximum efforts should be made to reduce the differences in competences between individual groups of persons in terms of skills related to information and communication technologies and skills from the STEM group (Science, Technology, Engineering and mathematics), [8].

Since 2014, the digital progress in the European Union (EU) member states has been reported annually through DESI - an index for the penetration of digital technologies in the economy and society. The main indicators assessed are human capital, connectivity, internet use, digital technology adoption, digital public services. According to the progress report of Bulgaria, in 2022 Bulgaria ranks second to last (11). Bulgaria's lagging behind average European levels in terms of "implementation of digital technologies" and "human capital" is significant.

In recent years, with the support of the Ministry of Education, continues the implementation of projects

related to the completion of WI-FI zones and networks in schools continues; building STEM centers; the training of software specialists and others [18], [19], [20]. Research continues on the development of the digital competence and creativity of Bulgarian learners in the use of new technologies, as well as their application in the creation of interdisciplinary methods and approaches to learning in a face-to-face and online environment [1], [6], [12], [14], [15], [26]. Initiatives aimed at familiarizing learners and trainers with current technological solutions in various industries are also increasing [9], [10], [13], [16], [24], [25]. For the quick informing about a new technology or updating knowledge and skills for an already known technology, it is appropriate to organize short trainings [2], [3].

II. DANCE WITH PHOTON ROBOT

Being inherent to every person, dance gives an opportunity to experience a momentary feeling, to describe one's own view. On the other hand, it is also a way to break away from everyday life. In 2017, Choreography curricula were adopted at the Ministry of Education and Science, aimed at preserving folk traditions and the Bulgarian dance “Horo”. Regarding the development of "Mathematical competence and basic competences in the field of natural sciences and technologies", the program for the 6th grade specifies "application of graphic models and regularities in the visualization of dance forms and their compositional constructions", "participation in dance activities related to the expressiveness of the dance and the ability to depict various natural objects and phenomena, seasons, animals, work activities, etc." For the same classes in the subsection 'Digital Competence' there is 'use of software to record and reproduce the dance.' The mastery of multi-element movements; the knowledge of diagonal; coordination through a given degree measurement is laid down by the Ministry of Education and Science in the curricula for the 7th grade [17].

Creating a work by learning a new technology supports the development of digital competence [4], [5]. The opportunity to present one's own view on a given topic, through a brief depiction of an author's idea, is suitable for all age groups, regardless of their professional competences and personal interests.

The research will present a way to create a dance using a Photon Coding mobile application and its performance by a Photon Robot. Here we will describe movements created by some levels of the application and the result of repeating them, in a certain dependence, in order to create an "Author's Horo".

III. PHOTON ROBOT

Photon robot is a robot designed for use in all grades of the school system (Fig. 1), [23].



Fig. 1. Photon robot

Its use can be started even without prior knowledge and programming skills. Freely available applications created to work with it are available for Android and iOS mobile devices, as well as Windows, macOS and Chrome OS computers. In addition to the four programming interfaces: "Photon Draw", "Photon Badge", "Photon Blocks" and "Photon Code", when working with the robot, the integrated ones can be used - Scratch, Microsoft MakeCode, Apple Swift, JavaScript and Python [22].

After installing the Photon Coding mobile application (from the Google Play Store), you can choose from several levels of work of varying complexity (Fig. 2).



Fig. 2 Levels of Programming with Photon Coding

Here will be explained in more detail the levels of the section "Introduction to Programming" and "game at an arm's length" and some results of programming a dance with them. The Photon Coding mobile app downloaded from the Apple store matches exactly the one from Google Play which will be researched.

A. Programming with Mobile App Photon Coding: Photon Draw (Beginner Level)

When working with Photon Draw, movement is done by manually moving (touchscreen) the robot figure to an arbitrary point. Movement can be: forward; back; to the left; to the right; diagonally at an angle of 45° in a selected direction. In Fig. 3 are shown some of the steps of the "Author's Horo" dance.



Fig. 3 Coding "Author's Horo" dance Steps with Photon Coding: Photon Draw (Beginner Level)

To perform the dance in question, it is appropriate to repeat the same trajectory, at an appropriate angle, as many times as necessary, until ending in the starting position. When starting the preset path, a simulation starts on the blue screen. This visibility is available both when the robot is connected to the mobile app and when previewing before connecting. At <https://www.youtube.com/watch?v=-cwwfBPQ1QA&t=14s> the initial steps of movement can be observed.

B. Programming with Mobile App Photon Coding: Photon Badge (Intermediate Level)

Setting a trajectory through the next level Photon Badge is done in a pre-charted "Program" field. Selected blocks from the left menu can be directly placed into it. In this level, the capacity of using a "Program" field is up to 10 blocks. In this case, the option to program the steps of the dance in one of the additional "Function" tabs is selected (Fig. 4).



Fig. 4 Programming "Author's Horo" dance Steps with Photon Coding: Photon Badge (Intermediate Level)

This level allows the entire "Function 1" or "Function 2" section to be used as a stand-alone block, analogous to those in the left menu (Fig. 4). The degree of rotation of the blocks  and  is exactly 45°; and exactly 90° for blocks  and , without the possibility of change. As with the first level, here the set steps on the blue field on the right can be played in advance. At <https://www.youtube.com/watch?v=vZdBc1Gj8w&t=54s> one can observe the result of the sequence set in Fig. 4.

C. Programming with Mobile App Photon Coding: Photon Blocks (Expert Level)

When working with Photon Blocks, block programming is used. Similar to the Badge level, the option to create a sequence through a function and its repetition in the main section is used here. When determining the forward or backward movement, a specific length can be indicated to the nearest 1 cm using the scale of Fig. 5. The maximum length of one step is 100 cm.

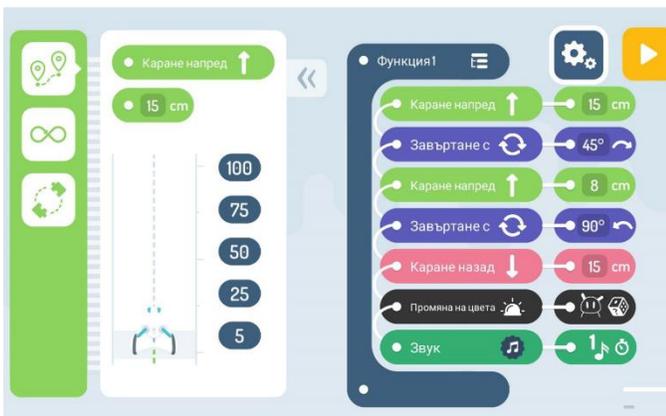
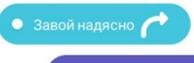
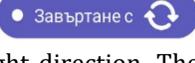


Fig. 5 Determining Travel Length in Photon Blocks (Expert Level)

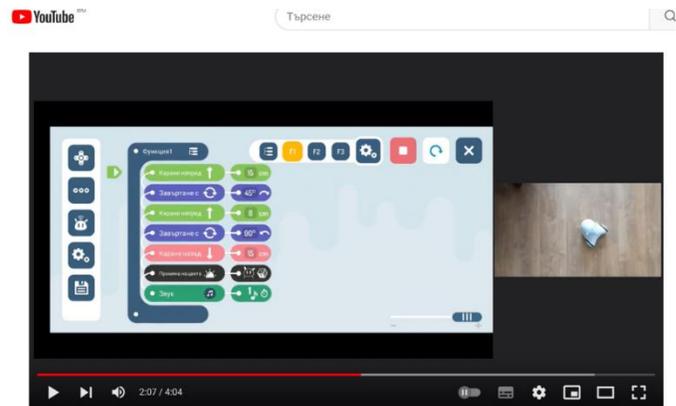
Both blocks  and  have a constant 90° angle of rotation. Block  allows rotation of a place in a left or right direction. The

exact angle is indicated by dragging the available pointer in the circle of Fig. 6.



Fig. 6 Determining rotation angle in Photon Blocks (Expert Level)

At <https://www.youtube.com/watch?v=Lwav3icDILs>, can be seen the dance programmed by Photon Blocks and performed by the Photon Robot (Fig. 7).



Photon Robot dancing - Photon Blocks

Fig. 7 Dance through Photon Blocks and its performance by Photon Robot

D. Programming with Mobile App Photon Coding: Photon Code (Master Level)

Working with Photon Code visually resembles the previous level in the arrangement of items in the left menu and the way of block programming. In contrast to the Photon Badge, here the movement forward and backward takes place through a single block, in which the direction and length of a step turns out (Fig. 8).

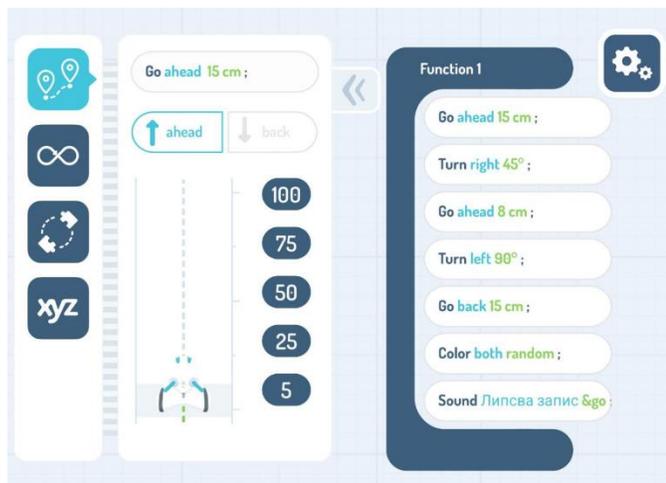


Fig. 8 Determining direction and step length in Photon Code (Master Level)

Determining the direction of rotation and degree measurement is also carried out with the help of one button, through the already familiar pointer and a choice between the left or right buttons (Fig. 9)



Fig. 9 Determining Direction and Rotation Angle in Photon Code (Master Level)

At <https://www.youtube.com/watch?v=DbIAHcDUDSQ> a video of the Photon Robot performing the dance in question coded using Photon Code (Master Level) is available.

IV. DANCE "IN THE GARDEN OF EDEN" WITH PHOTON ROBOT

In March 2023, the Photon Robot and the Photon Coding mobile application were presented to students from the seventh grade of 129 Primary School "Antim I", Sofia. Seventh-graders are the last graduating class under the old curriculum, after which the compulsory subject "Computer Modeling" was introduced, starting from the 3rd grade [21]. I.e. these seventh graders are beginners in using robots and programming. During the lesson, they were given the task

of describing their own dance "In the Garden of Eden". Specific elements of familiar dances or artist performances were noticed in:

- Two created "Dance of Happiness". For one of them, it includes movements from the so-called "griddy dance", popular among athletes practicing American football, as a way to celebrate a scored touchdown.
- Another seven students directly described a "griddy" dance. One variant is shown in Fig. 10.

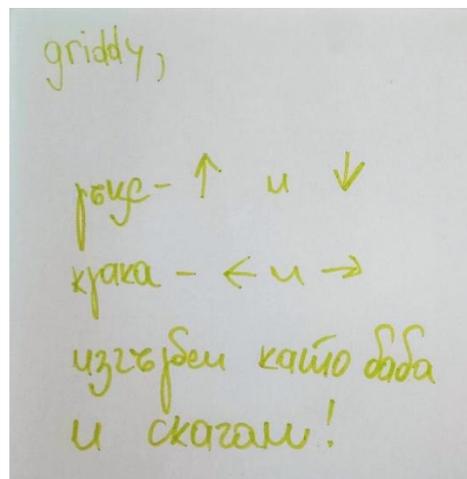


Fig. 10 Description of a "griddy" dance by a student

- Two indicated physical and sports classes when they play football as a paradise with favorite movements.
- For one of them, a dance in the Garden of Eden is "Hip hop in a circle".

Over half of the students chose to create their own choreography. In the ideas of three of them, the dance is "fast with many movements". For the rest who chose "slow" dance, similar definitions are noticeable such as: "gentle", "calm", "smooth movements", "beautiful", "love", "happiness" and others.

In terms of the number of people taking part in the dance, five students who made their own choreography described and/or portrayed a solo artist. In all of them, the dance is slow, including elements of ballet. For six students, the dance involves two participants. Of them, three opted for a fast dance with a partner, and the other three chose a slow dance. When depicting the steps of dances with couples, is noticed that half of the students use a single color, reflecting the movements of the specific partner (Fig. 11).

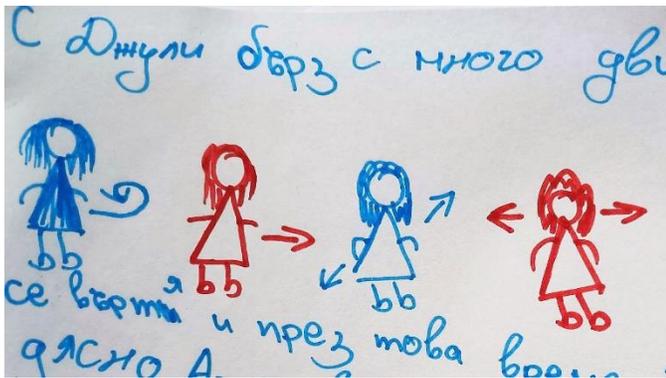


Fig. 11 Description and sketch of a fast dance with two participants by a student

After their allotted time to describe the dance, the students were introduced to the levels from the Photon Coding mobile app. Subsequently, each of them had the opportunity to perform their dance using the Joystick (Beginner Level), (Fig.12).

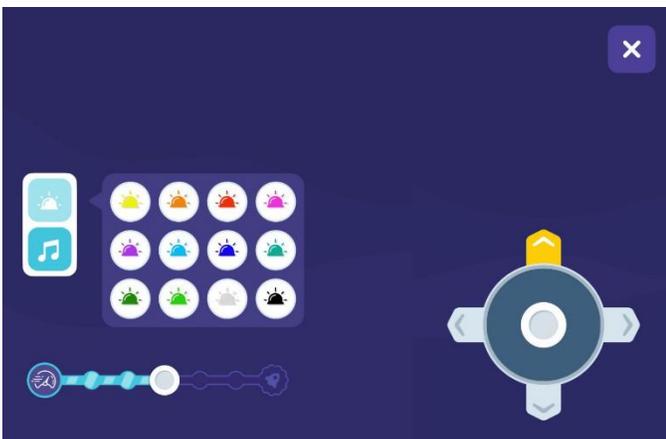


Fig. 12 Joystick (Beginner Level) from Photon Coding Mobile App

Only two of the students had programming knowledge from extracurricular visits outside of school. They chose to work with the same level that was prepared.

All students adjusted from a medium to the highest pace of movement. Students who chose to independently explore the possibilities of the joystick used either only the protruding buttons pointing to the four directions of the world, or only the central button performing rotary movements. The color change was tried by everyone without the need for initial assistance. Of more lasting interest were the available built-in melodies recreating animal sounds; signal alarms from emergency cars and those with a special traffic mode; exclamations. Only one student completed the steps of recording his own sound and submitting it to the robot for performance.

Eight students self-initiated downloading and trying out the app. A student who alone described the “Dance of the bread” (performed by Charlie Chaplin in the 1925 film “Gold Rush”) and independently downloaded the mobile app to

work with the Photon Robot chose to program steps through Photon Blocks (Expert Level), (Fig. 13).

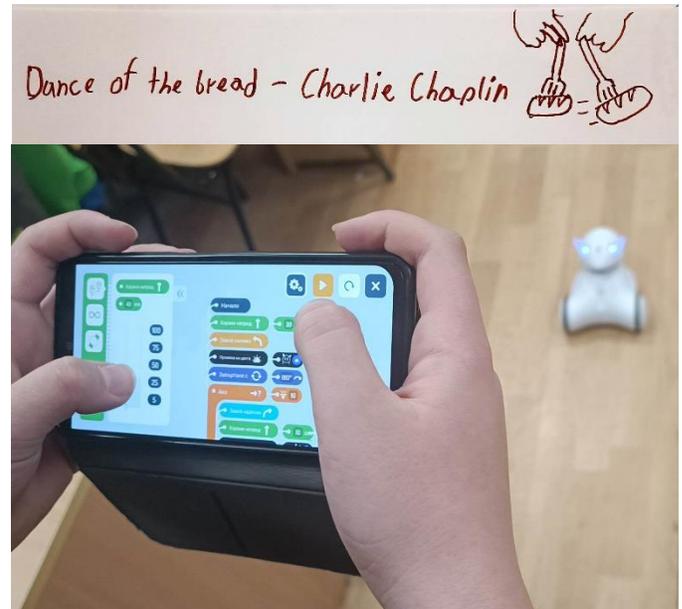


Fig. 13 “Dance of the bread” dance description and programming by a student with Photon Blocks – Level: Expert

The student had not worked with such software before. Observing the work of his classmates before him, he found that when changing the color in Joystick (Beginner Level), all the glowing elements of the robot change. Noticed that in Photon Blocks (Expert Level) each glowing element can be set individually and set contrasting colors. From his solo work, additional guidance was required only in inserting an appropriate repeat block and selecting elements to nest within it. When the dance programmed by him was first started, he noticed that already in the initial steps the set angle of rotation was not suitable. Stopping the simulation, the student changed angles in the dance and some step lengths to get as close as possible to the set choreography.

All the students tried to do a full rotation with the robot. In some cases, aiming to perform a pirouette on the spot (the ones who chosen ballet or ballroom dances). In other cases, a way to construct a circle with a precise radius was sought (for those who chose hip-hop or rhythmic couple dance). Imitating hand movements from the robot appeared as a challenge for the students. It also took several attempts to return the robot to a starting point when it was no longer “looking” in the same direction as the joystick controller. Three students rotated their whole body to a position matching that of the robot to assess which directions they should choose to move the robot to the selected starting point in the classroom at the beginning of the lesson. The others chose to rotate the robot in place until it stood in the desired direction, then move it back to the rendered point.

V. CONCLUSION

The presented results from programming a dance with the Photon Coding mobile application are a variant of a STEM/STEAM activity. The combination of artistic activities with new technologies supports the development of key competences - digital, mathematical, cultural, for independent learning. The results of the study conducted among seventh graders showed a fluency with the basic settings and buttons of the Joystick Level: Beginner of the Photon Coding mobile application. The dances described here combined elements of traditional and contemporary dance movements, expressed both through slow and fast, individual and group dances.

The use of Photon Robot with the described applications is suitable for beginners - from preschool or elementary education, as well as for students for whom "Computer Modeling" and "Computer Modeling and Information Technology" are not part of the curriculum. In addition to classes in a STEM center, there are also suitable opportunities for application in classes in Mathematics, Arts, Information Technology, Computer Modeling, "Computer Modeling and Information Technology", Physical Education and Sports, in interdisciplinary lessons and extracurricular activities. The natural next step is to control the Photon Robot with Scratch and Python programming as well as AI.

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