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AN EXAMPLE OF UNPLUGGED CODING EDUCATION IN PRESCHOOL PERIOD: ACTIVITY-BASED ALGORITHM FOR PROBLEM SOLVING SKILLS[1]

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ABSTRACT

This study aimed to introduce unplugged algorithm activities developed for preschool children and to examine their implementation process. The activities used in the study were designed to support preschool children to develop and apply different solutions to problem situations that require algorithmic thinking and to learn basic algorithm concepts, such as unit, loop, and command. In total, 24 algorithm activities were used with 16 kindergarten students over a period of 8 weeks. The classroom observations revealed that the students actively participated in the activities, were highly motivated, developed a variety of solutions to the problems, and made sense of the algorithm concepts. Explaining the general structure of unplugged algorithm activities and elaborating on how they can be used in preschool classrooms to promote problem solving skills of the students might offer guidance for practitioners and researchers in the field.
Keywords: algorithm, problem solving skills, activity-based algorithm education.

OKUL ÖNCESİ DÖNEMDE BİLGİSAYARSIZ KODLAMA EĞİTİMİNE BİR ÖRNEK: PROBLEM ÇÖZME BECERİLERİ İÇİN ETKİNLİK TEMELLİ ALGORİTMA

ÖZ

Bu çalışma, okul öncesi dönem çocukları için bilgisayarsız kodlama eğitimi temelinde geliştirilen algoritma eğitimi etkinliklerini tanıtmayı ve bu etkinliklerin uygulama sürecini incelemeyi amaçlamıştır. Çalışmada kullanılan etkinlikler, okul öncesi dönem çocuklarının algoritmik düşünme gerektiren problem durumlarına yönelik çeşitli çözümleri geliştirerek uygulamasını ve temel algoritma kavramlarını (birim, döngü, komut) öğrenmesini desteklemek amacıyla tasarlanmıştır. Hazırlanan 24 algoritma etkinliği, 16 anaokulu öğrencisiyle 8 haftalık bir süre zarfında uygulanmıştır. Çalışmada uygulanan algoritma etkinliklerine çocukların severek katıldıkları, aktif katılım sağladıkları ve problem durumlarına birden fazla çözüm önerisi geliştirerek algoritma kavramlarını kazandıkları görülmüştür. Etkinlik temelli algoritma eğitimi uygulamalarının genel yapısının nasıl olabileceğinin ve sınıf içi uygulamalarda problem çözme odaklı bir şekilde nasıl uygulanabileceğinin açıklanmasının uygulayıcılara ve alandaki araştırmacılara yol göstereceği düşünülmektedir.
Anahtar kelimeler: algoritma, problem çözme becerileri, etkinlik temelli algoritma eğitimi.

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INTRODUCTION

According to the Partnership for 21st Century Learning (P21), the essential skills that students should master to be successful in today's world include critical thinking, creativity and innovation, collaboration, communication, problem-solving, information and technology literacy, and life and career skills (P21, 2019). Additionally, in recent years, coding has emerged as an important skill that all students should learn (Arslan & Arçelik, 2019). Many countries in Europe have included coding in their curricula in order to develop problem-solving skills, which is one of the essential skills aimed for students to gain (Sayın & Seferoğlu, 2016). Coding is closely associated with "algorithmic thinking" and "computational thinking" (Durak & Şahin, 2018). It is recommended to bring algorithmic thinking skills to the fore and to train individuals who can think algorithmically and solve problems using algorithms (Gibson, 2012).

Algorithm Education in Preschool Period

In the current study, the term algorithm is defined as "A series of ordered instructional steps taken in a sequence to solve a problem or achieve an end goal." (Bers, 2018, p.5). According to Futschek (2006), algorithmic thinking involves the following abilities that are related to defining, clarifying, and constructing algorithms:

- to be able to analyze any given problem,
- to be able to define and specify the problem,
- to be able to choose the most suitable action for the problem,
- to be able to use the basic actions to construct a correct algorithm to solve the problem,
- to be able to consider any general or special cases of the problem, and
- to be able to enhance the efficiency of the algorithm.

In order for students to gain these high-level abilities, algorithm education should start in the early years of schooling to build a robust foundation.

Developing algorithm skills in preschool children contributes to children's ability to understand, use, apply, develop, and complete daily life algorithms (Voronina et al., 2016). Additionally, algorithm education has an important role in the development of children's skills such as exploring, using systematic solution methods, planning, organizing, cooperating, and discussing (Kalelioğlu, 2015). There are various algorithm-based applications on web-based platforms (e.g., Code.org, ScratchJr, Kodable, Daisy Dinasor, Move the Turtle) where children can learn and develop these skills through effective algorithm education (Baz, 2018). Apart from these platforms, there are also various practices that do not require computers to support children's algorithmic thinking and related problem solving skills (Highfield et al., 2018). In these unplugged coding practices, a coding process similar to computer programming is used to plan the solution of a problem step by step, shown in a flowchart. However, these coding practices do not require computers, and they use a language that people can read instead of a language that machines can read. In addition, because physical materials are used in unplugged coding, it is suitable for preschool students who are concrete thinkers (Lee & Junho, 2019).

With unplugged coding, children are given the opportunity to perform activities related to coding concepts such as algorithm, loop, unit, and command without the need for any digital technological tool (Canbeldek, 2020). The basic algorithm concepts included in the activities of this study are as follows: A *unit* is a general expression to denote any action followed in the algorithm. A *command* is an instruction to execute a unit or loop within the algorithm. A *loop* is related to actions performed with certain sequential values. A cyclic structure that repeats certain blocks (codes) in algorithms with a given number of times is called a "loop" (Vatansever, 2012). The overall purpose of the unplugged algorithm activities designed in this study is to support students in developing algorithmic thinking skills and using these skills to solve problems encountered in daily life.

PLANNING THE ACTIVITIES

Each activity designed in the current study involved the following subtitles: subject area, concepts and vocabulary, curriculum standards, performance indicators, learning process, and assessment. The basic algorithm concepts were introduced to students from simple to complex, starting with the unit concept, then command, and finally loop. The main cognitive skills targeted were problem-solving skills. These skills included noticing and defining problems, asking questions to clarify the problem situation, examining the information necessary to solve the problem, predicting the results, analyzing the reasons behind solution methods, and pointing out the important aspects of the problem situation (Aydoğan, 2012). In addition, the curriculum standards and performance indicators related to problem-solving skills in the Ministry of National Education (MoNE) 2013 pre-school education program were included in the activities. In particular, curriculum standard 19 "Generates solutions to problem situations." in the domain of cognitive development formed the basis for all activities. The performance indicators of this standard are as follows:

- Describes the problem.
- Suggests various solutions to the problem.
- Selects one of the solutions.
- Explains the reason for selecting a particular solution.
- Tests the selected solution.
- If a solution method does not work, the students try a new solution method.
- Suggests creative solutions to the problem.

As a result, 24 unplugged coding activities were designed in order to develop students' algorithmic thinking and related problem solving skills. The activities were reviewed by an expert and finalized based on the expert opinion.

ACTIVITY IMPLEMENTATION

The activities were designed for children aged 5-6, considering their cognitive, affective, and psychomotor developmental levels. They were implemented with kindergarten students (n=16) in the Western Black Sea region of Turkey in the spring semester of the 2018-2019 academic year. The necessary legal permissions were obtained from the Provincial Directorate of National Education, and a research process in accordance with publication ethics was followed. The activities were carried out in the workshop class of a kindergarten 3 days a week (Monday, Wednesday, and Friday) for 8 weeks. The activities were contextualized using the character Arya the Bee. Each activity consisted of a problem situation that Arya encountered in her daily life. The students were required to solve these problem situations using various algorithms within their small groups of four members. Each activity was completed in approximately 30 minutes. The algorithm setup was prepared using wooden cube blocks to help the students understand the concept of unit meaningfully and accurately. An algorithm setup prepared by the researchers is given in Figure 1. All the arrows, characters, and images in the activities were made of eva foam. The materials required for the activities are as follows:

- a set of 100 colored wooden cube blocks to build the algorithm setup,
- 5cm x 5cm figures made of eva foam (mother bee, father bee, child bee, faucet, flower, shoes, etc.),
- various objects (5cm long) made of eva foam (arrows for direction, colored printouts for the command concept, arrows with numbers on them for the loop concept), and
- scissors and glue.

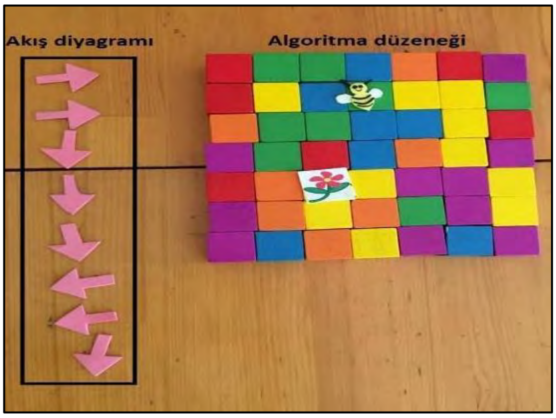

Figure 1. Flowchart and Algorithm Setup

First, the students were introduced to the algorithm setup that they would use in the activities. They were informed that each arrow in the flowchart and the top surface of each cube in the algorithm setup were named a unit. The activities were implemented in order from simple to complex concepts: unit, command, and loop. The learning process was evaluated using assessment questions in order to find out how the students performed in the activities, what they felt about the activities, and how they transferred the algorithmic thinking to daily situations that were similar to the problem situations used in the activities.

Sample Algorithm Setups

The activities at the simple level focus on the concept of unit, which is one of the basic algorithm concepts, while the activities at the complex level address the concepts of incorrect unit, missing unit, command, and loop. In the activities that focus on the concept of unit, the teacher presents the algorithm setup to students. Students' task is to create the flowchart using the arrows and to take Arya the Bee to her target point. In complex level activities, unlike the simple unit activities, the teacher prepares both the algorithm setup and the flowchart in advance and shows them to students. Students examine the algorithm setup and the flowchart. Then, they determine the incorrect or missing units in the flowchart (debugging) and reconstruct it to obtain the correct algorithm. Students should test the new algorithm using the setup and see if the goal is achieved or not. For example, the algorithm does not take Arya to the endpoint due to the missing units in the flowchart for the setup given in Figure 2a, and due to the extra number (incorrect) of arrows in the flowchart given in Figure 2b. In these activities, students are expected to find the debug in the algorithm and to rearrange the flowchart to form the correct algorithm with their groupmates.

Figure 2a. A Flowchart with Missing Unit

Figure 2b. A Flowchart with Incorrect Unit

The commands differ according to the problem situations. The command icons were prepared in similar size to the arrows in the flowchart using colored printouts. As illustrated in Figure 3a and Figure 3b, in the activities containing a command, Arya is taken to the target point by following the arrows in the flowchart. Then, students solve the problem by applying the given command (collect, remove, water, plant seeds, etc.).

Figure 3a. "Plant Seeds" Command

Figure 3b. "Water the Flower" Command

In the current study, the activities with the most complex structure are the ones that required using loops. A loop is used to perform the action of multiple units in the same direction with a single unit. If many units in the same direction are used in the algorithm, an arrow with a number indicating the repetition is used instead. Figure 4 shows a flowchart with a loop. The numbers on the arrows indicate how many times this movement will be repeated. In the loop activities, students are expected to take Arya to the target by moving Arya in the direction of the arrows as many times as the numbers on the arrows indicate.

Figure 4. An Algorithm Setup with Loop

In the following sections, examples from the current implementation are shared. Among the activities, *Arya the Bee's Shoes* for the concept of "algorithm", *Arya the Bee's Dirty Hands* for the concept of "unit", *Arya the Bee Helps Her*

Mother for the concept of "command", and *Arya the Bee Paints with Watercolors* for the concept of "loop" are elaborated as examples.

Arya the Bee's Shoes

This is a simple level activity and requires the following materials: shoe-tying algorithm worksheet, scissors, and glue. The concept targeted in the activity is "algorithm." The learning process of the activity was as follows:

The activity started with the teacher introducing the concept of algorithm to the students. The teacher said to the students: "I want to talk about a concept, algorithm. We call each method that we use to solve problems an algorithm." In order to help the students concretize this abstract concept, the teacher explained the steps of cake making:

> Well, in fact, we do a lot of our daily activities with algorithms, but we don't realize it. For example, how do we make a cake? We prepare the necessary ingredients; then we put the oil in a bowl; next, we add sugar to the same bowl; and we mix the oil and sugar. Afterward, we crack an egg into the same bowl and mix again. We add flour and mix again. We put the mixture into a pan and place it in an oven. Finally, we set the degree of the oven and bake the cake. All the steps we follow to bake the cake form an algorithm.

Here, the goal is for students to comprehend the algorithm as a list of steps that can be followed to complete a task. The teacher asked the students, "What else do we do step by step, like baking the cake?" Some of the answers students gave included cooking soup and food, planting flowers in pots, washing hands with soap and water, and starting and driving a car. The teacher engaged the students in discussing each of these examples to prepare them for the algorithm activity. When he felt that the students are starting to make sense of the concept of algorithm based on the comments made in the discussions, the teacher asked "Okay, we discussed the concept of algorithm together and gave examples. What did you learn?" The students' answers included comments such as algorithm occurs in many daily activities, it is done step by step, and all of the steps are called an algorithm. This part of the lesson indicated that the students started to comprehend the meaning of an algorithm.

Next, the teacher started the main activity by telling a problem situation about Arya the Bee: *Arya the Bee got out of bed excitedly in the morning. After she had her breakfast, she put her coloring books in her bag and went to the door to put on her shoes. She tried to put on her shoes but couldn't.* The teacher asked the following question to the students: "What do you think that how we can help Arya the Bee to put her shoes on?" Some of the student answers were as follows: "We should sit Arya the Bee down and then let her try again." "We should model Arya how the shoe is tied." "We should first untie her shoelaces and then put her foot in the shoe and tie it." Then, the teacher distributed the shoe-tying algorithm worksheets that he had brought to the class (Figure 5) and said, "Let's cut out the shoe-tying images on the worksheet with scissors, put them in the correct order, paste them to the numbered blank spaces, and help Arya put her shoes on." The teacher monitored how the students completed their worksheets. For those students who struggled, he scaffolded their thinking process by asking them to think about what steps they perform when putting on their shoes.

1	2	3

Figure 5. Arya the Bee's Shoes Activity Worksheet

Reflections on the Arya the Bee's Shoes Activity

In this activity, the students needed to make sense of the concept of algorithm and solve a real-life related problem using algorithmic thinking. It was observed that all students created a correct algorithm by arranging and sorting the problem situation given on the worksheet and that they solved the problem correctly. At the end of the activity, the teacher facilitated a whole-class discussion and posed reflective questions about the activity. In order to get the opinions of the students, the teacher asked several questions such as "Which method did you use to put Arya's shoes on? Did you have any difficulty while figuring out how to put on the shoes? If so, what was it?" Some of the answers given by the students included "I listed step by step how I put on my shoes. Then I glued the cut out papers into the squares, it was easy to sort and paste." "I didn't have any difficulties today, but it is sometimes difficult for me to tie my laces." Students' responses to the teacher's assessment questions reflect the students' understanding of how the concept of algorithm is used in the solution of daily life problems. The students expressed the idea that sequential instructions are examples of an algorithm, and they shared real life examples such as baking cakes, making cakes, planting flowers/seeds, and putting on shoes.

Arya the Bee's Dirty Hands

This activity involved using a pre-prepared algorithm setup. Colored cubes, arrows made of eva foam, and images of the story characters were used instead of worksheets in the activities in which an algorithm setup was used. The activity "Arya the Bee's Dirty Hands" aimed to teach the concept of "unit" to the students. The target in the algorithm setup was a "faucet." The learning process of the activity was as follows:

To promote a hands-on learning approach for the concept of algorithm, the teacher brought colored wooden cubes to the class. The teacher left the colored wooden blocks on the table and asked the students what they were and what could be done with them. After the students shared their predictions, the teacher explained that they were going to engage in new activities related to the concept of algorithm that they learned in the previous lesson, and then he constructed the algorithm setup. In this activity, the teacher aimed for students to understand the unit concept. He placed the figure of Arya the Bee, made of eva foam, and the figure of a faucet, the target of the problem that students would solve, on the square-shaped algorithm setup made of wooden cubes.

The teacher started the activity by asking the following question to the students: "Arya the Bee has been playing with the soil in the garden with her friends and her hands are very dirty now. How can Arya clean her hands?" The students suggested different solution methods to clean Arya's hands such as "She should go to the bath and wash her hands." "If they are not too muddy, she can use wet wipes." "If her hands are wet, she can use a napkin first." The class agreed that Arya should wash her hands using water and soap. Accordingly, they constructed the algorithm by using the arrows and aimed at reaching the faucet.

The students were told that Arya the Bee should be moved to the blocks with faucet figures by using the arrows. Figure 6 shows a setup that was used for four different unit tasks. In the first task, the students moved Arya 1 unit to the right (east). In the second task, the students moved Arya 1 unit up (north). In the third task, the students moved Arya 1 unit to the left (west). In the fourth task, the students moved Arya 1 unit down (south). In each task, Arya was moved back to the starting point. This design allowed students to use four different "unit" movements.

Figure 6. Arya the Bee's Dirty Hands "Unit" Activity

Reflections on Arya the Bee's Dirty Hands Activity

At the end of the activity, the teacher asked the students several assessment questions, such as "What strategy did we use to help Arya the Bee to clean her dirty hands?" and "How did you feel while engaging in this activity?" The students' responses to these questions included "We helped her go to the faucet." "We used different ways to go to the faucet." "We took her to the faucet in many ways." "We took her to the faucet in 4 different ways so that she could wash her hands." "I liked it; we moved the bee to the faucet by using the arrows' directions." "I was happy when she reached the faucet because not only the bees but also, we should wash our hands before and after eating." All of the students were able to correctly form the algorithm suitable for the problem situation. They were aware of different solution methods for the problem. The students did not have any difficulty in applying the unit concept, and they solved the problem by using the correct units. They moved the bee figure from the starting point on the algorithm setup according to the direction that the arrow in the flowchart points. When the students used the last unit, the bee reached the target (faucet). All of the students completed the algorithm correctly, and they enjoyed participating in the activity.

Arya the Bee Helps Her Mother

This activity aimed to teach the concept of "command" to the students. The target in the algorithm setup was a "flower." The learning process of the activity is described below.

The teacher started to tell the following story by explaining to the students that Arya the Bee has a problem, and their task is to help her solve this problem:

> It is a sunny summer day with many fragrant flowers. Arya the Bee's mother collects nectar from flowers in preparation for winter. Arya's mother is too tired because there are too many flowers. Noticing her mother's tiredness, Arya the Bee wants to help her mother, but she does not know how to collect flower nectar.

The class discussed the story under the teacher's guidance and agreed that the problem in this story was that Arya the Bee did not know how to collect flower nectar. The teacher asked: "Arya the Bee wants to collect nectar to help her mother. How can we help Arya?" Different answers given by the students were discussed in the class and it was decided that Arya should first move to a flower and then collect the nectar by sucking it with her mouth. Next, the teacher explained that different from the algorithms they have studied so far, in the current task, the "collect" command should be added to the flowchart for Arya the Bee to collect nectar from the flowers when she reaches them. He asked each group to create a flowchart according to the algorithm setup and noted that while creating the flowchart, they would use the arrows and the collect command. As Figure 7 shows, there are images of Arya the Bee and two flowers on the algorithm setup, while there are two "collect" commands in the flowchart. The teacher made the following explanation to the students who reached the first flower on the algorithm setup:

> So far, we only took Arya the Bee to the flower. We have to tell her what to do to collect the nectar. We call this a "command." We should give the command "collect" to Arya so that she can collect the nectar from the flower.

When students reach one of the flowers on the algorithm setup, they should add the "collect" command to the flowchart as a unit. The teacher made sure that all the groups used the collect command by saying "Come on guys, let's create an algorithm, let's take Arya the Bee to the flowers using the arrows and have her collect the nectar from the flowers using the 'collect' command."

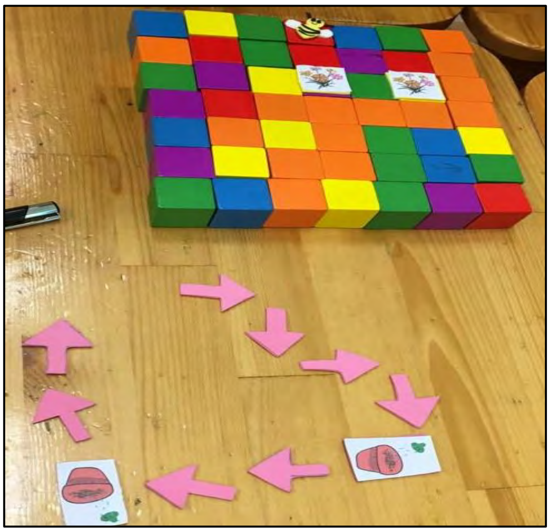

Figure 7. A Sample Algorithm Created by the Students Using a Command Unit

Reflections on Arya the Bee Helps Her Mother Activity

The purpose of introducing the concept of command to the students is to help them understand what the basic functional practice is when developing solutions for problems. "Arya the Bee Helps Her Mother" activity was designed to reach this goal. The students seemed to understand this goal as they spoke about the need for using the collect command in order for Arya the Bee to collect the nectar once she reaches a flower. They comprehended that the collect command has a certain function, i.e., have Arya collect nectar from the flower, and in this way Arya the Bee could help her mother. The students also explained that without this command, Arya the Bee could only reach the flower without collecting nectar, thus she would not be helping her mother.

In this activity, the students used different algorithms to take Arya to both flowers to collect nectar. The variation in the use of commands and arrows in the flowcharts shows that the students made sense of the concept of command. The flowchart in Figure 7 is an example of an algorithm created by one group. The group created a correct algorithm by using the following codes respectively: 1 unit right (east), 1 unit down (south), 1 unit right (east), 1 unit down (south), "collect" command, 2 units left (west), "collect" command, and 2 units up (north). Different algorithms were shared in the class, and it was emphasized that there could be different ways to solve a problem.

At the end of the activity, the teacher asked the students several assessment questions: "How did you get Arya to collect the nectar? Did you find it difficult to do this? How do you help your mother at home?" Some students answered these questions by comparing the learning process of the command concept to the previous algorithm activities. For example, one student said, "We had a little difficulty because it was not like what we did in taking Arya to the faucet activity." Another answer was as follows:

> We tried to take Arya to the flower by using the arrows, but we used the wrong units, so we checked it again and then we were able to take Arya to the flower like that. After we fixed it, we added the collect unit and collected the nectar from the flower, and then using the arrows, we took Arya back to the start.

The problem situations in the activities allowed the students to use the trial and error method and helped them detect and fix the errors in their codes. Another answer was "I did not have any difficulty. We tried to use a different way on the way back, but we had to choose the same way because there were not enough arrows." This comment shows that the students tried different solution methods, but the materials were limited. To sum up, in this activity, the students used the command unit and created an algorithm by ordering the units in the flowchart correctly.

Arya the Bee Paints with Watercolors

This activity was designed as a complex level activity and aimed to introduce the concept of "loop" to the students. The target in the algorithm setup was a "flower." The learning process of the activity was as follows:

As a warm-up activity, the students stood up and were told to follow the commands given by the teacher. They played a game that aimed to help students construct an informal understanding of the concept of a loop. The teacher said, "Clap your hands, clap your hands, clap your hands." and the students clapped their hands each time. "Shake your waist, shake your waist, shake your waist," the teacher said and the students shook their waist each time. Then, the teacher asked, "All right children, how many times did we clap our hands and shake our waists?" The students shouted "Three!" The teacher introduced the concept of the loop: "Okay guys, what if instead of repeating the instruction 'clap your hands' three times, I say 'clap your hands three times' at once? So instead of repeating, we do it using a loop?" He continued by saying, "Come on, let's clap our hands three times." and clapped his hands three times simultaneously with the students. After the teacher instructed, "Shake your waist three times." they all shook their waist three times. The teacher told the students that what they did was an example of a loop. He explained that the loop was the execution of repetitive actions. Then, the story of the algorithm activity was told:

> Arya the Bee woke up excitedly in the morning because she will be painting with watercolors at the school today. She gets ready and goes to school. All her friends and Arya the Bee prepare the needed materials for watercolor painting. They start to paint with watercolors. Arya the Bee wants to paint a flower. We will help Arya the Bee to reach the flower that she wants to paint.

In the algorithm setup, Arya the Bee was placed 3 units left (west) and 4 units down (south) of the flower (or 4 units down (south) and 3 units left (west) of the flower). "Guys, now we have to take Arya the Bee to the flower, but this time we will use fewer units of arrows. We should use arrows with numbers on them. We should place the loop arrows that will take Arya the Bee to the flower on the flowchart," the teacher said and the students completed the loop activity.

Reflections on Arya the Bee Paints with Watercolors Activity

In this activity, the students used less units in the flowchart by using the loop unit. Although some students created a correct algorithm in a shorter amount of time than the allotted period (30 minutes) by using the loop unit, some students required some additional time (about 10 minutes) to create a correct algorithm. For example, a group using additional time first used the unit arrows; they placed 4 units down (south) and 3 units left (west) on the flowchart and took Arya the Bee to the flower. Later on, these students revised their algorithms by using a loop upon the teacher's question of how to solve the problem using fewer arrows. Some groups created their algorithms faster because they used loops at the beginning of the activity (Figure 8). These students said that they did not have any difficulties while completing the activity, they enjoyed it, and they used different loops at home on their own: "It wasn't difficult for me. It was fun. We easily found the arrows with numbers on them. We finished it quickly because we didn't use too many arrows. I even did a loop for Arya the Bee at home."

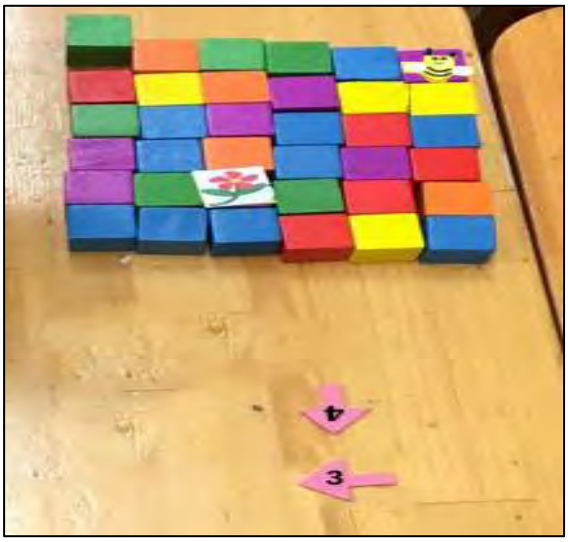

Figure 8. A Sample Algorithm Created by the Students Using a Loop Unit

In the assessment phase of the activity, the students reflected on the activity and explained that loops are useful because they are created with less units and that loops can be used for repetitive instructions. At the end of the activity, the teacher asked the students, "What do you think about using loops to help Arya the Bee to reach the flower? What parts of the activity were difficult for you? What parts were fun?" Some students spoke about having difficulty in creating a correct algorithm using loops. A student comment exemplifying this situation is as follows:

> Actually, it was difficult at first, teacher. We had to count the units in the setup one by one because the loop needed too many arrows. Then we counted with you and I found the arrow with the correct number and put it to the right. Then what else, hmm, I think this is the hardest Arya Bee activity.

Another student made the following comment: "It was fun, I liked it, but it was difficult because we were always counting one by one and putting the arrows. We tried to find the arrow with the correct number. It took us some time to decide." Despite these difficulties, it was observed that the students enjoyed solving the problems presented through the character of Arya the Bee. The main purpose of teaching the concept of loop in this activity was to help students consider time management and using the most efficient way while developing solutions for the problems. All students completed the loop activity successfully under the guidance of the teacher. However, some groups completed the task quickly while some other groups requested additional time, and they found the activity challenging. Successful completion of the activity by all students, even though some found it challenging, shows that the activity is appropriate and useful for the developmental level of the students.

CONCLUSION and SUGESTIONS

Digital skills, as one of the 21st-century skills, are accepted as part of problem-solving skills, which highlights the importance of coding education, in other words, knowing algorithm-based programming languages (Sayın & Seferoğlu, 2016). This paper shares examples of algorithm-based unplugged coding activities designed to support the problem-solving skills of 5-6-year-old children in preschool education and reflections on the activity implementations. The algorithm setups and the activities designed in the current study can provide guidance for the preschool teachers who are interested in using coding activities with preschool children.

The problems used in the current study were constructed based on the experiences of Arya the Bee, a character that was interesting for the students. This design helped the students make sense of the problems and associate the algorithm concepts and problem situations with daily life. Students used problem-solving skills such as defining the problem, choosing the most appropriate solution to the problem, and developing an algorithm to solve the problem during the activities. In this respect, the current study is compatible with previous research studies that reported the effectiveness of algorithm-based activities in supporting students' problem solving skills (Bers et al., 2014; Keren & Fridin, 2014; Mittermeier, 2013; Oluk et al., 2018).

In light of the assessment of student learning during the activities that focused on basic algorithm concepts (unit, command, and loop), suggestions for future implementations are shared below: In order to develop problem-solving skills of students with algorithm education, teachers can design the learning environment by using appropriate materials and facilitate students' algorithmic thinking skills. In these efforts, it is important to consider the characteristics of the student group, such as age, gender, developmental level, and interest areas, as illustrated in this study.

The participating students asked for completing the activity again in some of the algorithm activities. In addition, after completing the given tasks, some students wanted to construct different algorithms using the algorithm setup by posing different problems involving Arya the Bee. Students asking and solving their own problems is in line with an inquiry-based approach to education, and it is important for the activities designed within the scope of the current study to offer these opportunities in terms of deepening student learning. It should be noted that the algorithm activities were actively completed by the group members, at times they were repeated, and the problems were solved collectively based on group discussion. In light of the current implementation, it is recommended that teachers create opportunities for students to ask their own problems and seek solutions with their groupmates while engaging in the activities.

The students expressed the view that it was challenging to create a correct algorithm in the complex level loop activities. In the current implementation, the students were given 30 minutes to complete each activity. This decision was given based on the students' age and developmental levels. However, the allotted time was insufficient, especially for the complex level activities, and the activities were completed by giving additional time. Accordingly, teachers may adjust the time for each activity depending on the complexity of the algorithm components.

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