

Designing A Computer Programming Environment For Gifted Students: A Case Study

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ABSTRACT

The aim of this study was to design, implement and evaluate the programming process for gifted students and offer suggestions to teachers and researchers. For this purpose, 5 gifted students were provided programming activities for ten weeks. Scratch was used in the programming training process. The qualitative data was collected by observation, interviews and written forms. The results showed that students' interests and needs should be taken into consideration in programming teaching plans. The duration of the lessons should be kept flexible and the programming activities should be project-based. The study revealed that game programming increases the attendance and motivation of the gifted students. In future research, programming instruction can be repeated by making necessary corrections and researched in different dimensions such as motivation, academic achievement and self-efficacy.

Keywords: *Gifted child, computer science, programming, Scratch*

INTRODUCTION

Giftedness arises from the combination of generic or special ability, above average creativity and motivation (Renzulli & Reis, 1997). According to Rogers (2002); it covers the profiles considered gifted such as mental ability, special academic ability, creativity, leadership, and visual and performing arts. Gifted individuals have extensive and detailed memories (Clark, 2002), are curious (Blackburn & Erickson, 1986), creative (Torrance & Goff, 1989), self-regulated learners (Risemberg & Zimmerman, 1992), have excellent problem solving skills (Ataman, 2014; Sak & Maker, 2005) and high analytical thinking skills (Silverman, 1993).

The gifted students need special education beyond standard education (Hargrove, 2009; Renzulli & Reis, 1997). Providing a standardized education for these students can lead to the loss of existing potentials (Callahan, 2005). So, education programs should be planned in a way to enhance interests and skills of gifted students considering the needed environments (Callahan, 2005; Davis & Rimm, 2004; Young & Balli, 2014). The education services of gifted students are generally under investigation in headings of acceleration, grouping and enrichment. Early start in kindergarten or elementary school, unclassified elementary school groups, mixed class groups, and grade-skipping implementations are included in acceleration (Steenbergen-Hu & Moon, 2011). Enrichment services include activities beyond the curriculum according to the interests and needs of the learners and in different disciplines (Davis & Rimm, 2004). Grouping is educational services that offer the opportunity to work together with gifted individuals who are similar in certain characteristics. Private school, private classroom and home schooling practices are included in this group (Ataman, 2014).

Gifted education varies according to countries. There is no common gifted education system in European countries. Most European countries consider giftedness to be related to intelligence. European education policy, however, encourages countries to implement differentiated teaching in the education of the gifted (Sekowski & Lubińska, 2015). In the United States, the National Association for Gifted Children (NAGC) offers full-time and part-time training to gifted students. Some college campuses have program of science and math for gifted students. The Center for Talented Youth (CTY) identify gifted students in mathematics and direct these students to summer programs (Gilheany, 2001). According to the report prepared by the Turkish Ministry of National Education (MoNE, 2012), periodic trainings are given to students in associations and foundations established by families besides schools and centers in the USA (Council for Exceptional Children). In Russia, differentiated curricula are applied to expand and enrich all schools for gifted students, as well as private schools. In the Czech Republic, the Netherlands and Switzerland, education is offered to gifted students in a different class in the formal educational environments; whereas Finnish education system has focused on accelerating and enriching implementations.

In Turkey, gifted education is provided three groups as special schools (science high school), special classes (only in private schools) and after-school programs (Science and Art Centers) (Sak et al., 2015). Science and Art Centers, known as SACs are independent private education institutions established to ensure that gifted students who attend pre-school, primary and secondary education institutions become aware of their individual abilities and use them at the highest level. Student selection for these centers takes place in three stages as teacher nomination, group intelligence test and individual IQ test. SAC uses the project-based learning and development of special talents training models. In addition to basic fields such as physics, chemistry and mathematics, gifted students also can take different courses or workshops such as robotics, data mining, astronomy, ethics, statistics, geology, leadership, visual arts, archaeology, creative writing (MoNE, 2019).

At the beginning of the subjects studied in computer science for many years is teaching of programming. Learning to program contributes to development of various skills beyond gaining basic knowledge of programming. Programming improves problem solving skills (Saeli, Perrenet, Jochems, & Zwaneveld, 2011; Schwartz, Stagner, & Morrison, 2006), high-level thinking skills (Kafai & Burke, 2014) and creative thinking skills of students (Kobsiripat, 2015). Generally, beginner programmers perceive it difficult (Lahtinen, Ala-Mutka, & Jarvinen, 2005). Coding is one of the most problematic areas for students in the programming (Özmen & Altun, 2014). Even with the educational benefits, textbased programming has not been adopted because it requires language syntaxes and constructs knowledge and strong keyboarding skills (Lee, 2011). To make learning easier, interesting and entertaining visual programming environments have been developed (e.g. Scratch, Alice, Small Basic, Net Logo) (Schwartz et al., 2006). The environments, which visualize the algorithm, embody the coding process and provide easy editing possibilities (Cooper, Dann, & Pausch; 2003). Sáez López, González and Cano (2016) found out that working on projects in the visual programming environment increases motivation of students. It is also important to know which methods and techniques can be used in programming education. Project based learning can be preferred in programming because it helps to recognize the importance of a real problem and necessity of each meaningful pieces (Kaşaracı, 2013). Game-based learning is effective in understanding the logic of programming (Cristiane et al., 2010), and encourages students to do programming (Kazimoglu, Kiernan, Bacon, & Mackinnon, 2012; Theodoraki & Xinogalos, 2014).

Programming has just recently emerged as an area of interest in gifted education (Karnes & Siegle, 2005). Gifted children and their parents are also fascinated by programming, as it permits young learners to a lucrative and exciting career (Schroth, Daniels, & McCormick, 2019). Siegle expressed programming by writing, *"gifted and talented students excel at and are drawn to the thinking strategies used in the coding process"* (Siegle, 2017, p. 117). For this reason, gifted educators suggest that the learning environment should be able to provide complex and real-world problems, to create innovative products, and to learn higher order thinking skills (Troxclair, 2000). When the needs of gifted students and the contributions of programming are compared, the clearer it became that programming would align well with the needs of gifted children (Ashenfelder, 2017; Yıldız-Durak, & Güyer, 2018). In this context, gifted students should be provided with suitable programming environments and courses. But unfortunately, the education given to gifted in SACs

focuses on mathematics and science fields and students interested in programming are adversely affected (Geçkil, 2012; Keskin, 2006). For this reason, gifted students have positive attitude towards programming, should be directed to this field without losing time (Keskin, 2006).

So far, few studies have investigated giftedness and programming. O'Brien, Friedman-Nimz, Locey, Denson (2005) explored possible patterns of "computer technology talent". They investigated formative experiences, cognitive abilities, and personality characteristics of 9 gifted high school students. As a result of interviews and analyzes, there are two subtypes of computer technology talent among the students: programming and interfacing. Researchers emphasize that providing educational options to children interested in this field is crucial to talent development. Yıldız-Durak and Güyer (2019) designed 15 weeks Scratch programming process for 26 gifted students studying at the 2nd, 3rd and 4th grades of primary school. Scratch program have positive effects on motivation and course participation because of the visual, color and sound elements. It was also concluded that the students' positive attitudes towards the computer course improved. Wang, Huang and Hwang (2014) evaluated the effects of project based learning activity using Scratch on different mathematics gifted and average students with the 91 secondary school students. The results of the research showed that gifted and non-gifted students achieved improvement. But, the mathematics gifted students outperformed the average students in terms of learning motivation, learning attitude, and problem-solving performance. Similarly, Siegle (2009) emphasized that Scratch supports gifted students' various thinking skills such as problem solving and logical thinking. In study of Hagge (2017), the 6th grade gifted students had digital storytelling with the Scratch program. The researcher focused on the usability of the Scratch program with digital storytelling during the implementation process. According to this research, Scratch is an ideal tool to providing a space with unlimited potential for creativity and gift to emerge via the design and redesign of multimodal products. It enables students to become active producers of knowledge and helps gifted educators to differentiate experiences for learners. Schroth, Daniels, and McCormick (2019) recommend programming books and platforms with features to parents so that children can explore their technology skills and experience learning. Ashenfelter (2017) provided programming training to 4th and 5th grade gifted students for 5 days. In teaching process, the researcher used Google CS First for the curriculum and material, and Scratch for coding digital story. CS is an ideal tool that teachers can use in programming because it provides easy process management, active, fun and voluntary participation. The stories provided opportunities to gifted students that to think creativity, to express emotions, to practice advanced comprehension of word nuances and metaphors, and to express their sense of humor.

The research was needed because current research focused on the results of programming teaching rather than on the process. It was designed in order to reflect the programming teaching process to gifted students with all elements and to offer suggestions to teachers and researchers.

In the context of this background, the primary goal of this study was to focus on the question "What should be considered in the process of programming instruction for gifted students?" Two research questions guided this study:

1. What should be considered in the process of programming instruction for gifted students according to the lecturer?
2. What are the opinions of the gifted students about the programming instruction process?

RESEARCH METHOD

Research Model

This study made use of holistic single case design as a method of qualitative research. According to Yin (2013), case study deals with real-life situations such as individual experiences, small group behaviours, implementation processes, school performance, and interpersonal relationships from a holistic perspective. For studying the situations that have unique characteristics and can be defined as end points in the process, a holistic one-state pattern seems appropriate (Yin, 1984). In the study, ten-week programming instruction

was given to gifted students, one hour per week. During the implementation, data were collected by means of observation, interviews and written opinion forms and in-depth analysis was performed.

Participants

The study group consists of five male students, one of the sixth grade, one of the ninth grade and three of which are eighth grade students, who were accepted to SAC in the 2015-2016 academic year. These students are interested in programming and want to study in this field. Since the ability in programming field was not recognized, SAC students had pre-research computer field introduction meeting and after this meeting. The participants in this study were four secondary school students and one high school student. The number of students in the support education programs must be between three and seven (MoNE, 2007). For this reason, the number of students in the study was limited and the students were selected on a voluntary basis. The lecturer is an assistant professor and has thirteen years of professional experience. The lecturer provided programming training at the secondary and high school level for six years and also organized Scratch training for students from various age groups. She was also involved in projects related to programming. The lecturer was involved in the research because she was an expert in programming. In order to learn about gifted students in the course of learning analysis; interviews were held with four SAC teachers, two female and two male, teaching biology, guidance, physics and science branches.

Data Collection Tool

Observations, interviews and written opinion forms were used for this research. The data collection tools are given in Table 1.

Table 1. Data collection instruments

Data Collection Instrument		When	With who
Observation		Throughout the research	Medium
Meeting	Unstructured	Pre-implementation	Lecturer
	Unstructured	Weeks 2, 4, 6, 8	
	Semi-structured	After week 10	Teachers
	Semi-structured	Pre-implementation	
Forms	Student status assessment notes	Weeks 5 and 6	Student
	Programming lesson assessment form	After week 10	Student

Observation technique was used to record the environment, performed activities, interpersonal interaction and other observable situations. The researcher acted as a part of the research group. For this reason, participatory observer role was adopted (Büyüköztürk, 2005). Observation notes were kept and voice recording was taken throughout the implementation. The notes were compared with the audio recordings to ensure the consistency of the data. Before the implementation process, semi-structured interviews with SAC teachers were conducted for learners' analysis. Three expert opinions were taken in the preparation of the interview form consisting of ten questions. The main focus of the interview was to obtain information about cognitive, emotional and social characteristics of the gifted students and their behaviors in the lessons, the motivation situations and their experiences related to the project-based work. In the research, an unstructured interview was held with the lecturer in order to determine the topics and to plan the environment before the implementation. On the second, fourth, sixth and eighth weeks, unstructured interviews focused on understanding the experiences and changes experienced by the lecturer in the process. At the end of implementation process, the "Programming Lecturer Interview Form" was designed with the opinions of three field experts in Information Technology (IT) to reflect the programming process with gifted students. The form consists of seven questions about student participation, applicability, contributions provided for student, observations about the process, recommendations and personal reflection. The interview was audio-recorded and transcribed for analysis. On the fifth and sixth weeks, the students write their opinions about the course as unstructured form. At the end of implementation process, "Programming Course Evaluation Form" was designed and was given to students. This form consists of nine



questions. Purpose of the form to obtain the students' reflections such as meeting the expectations, time, space, content, teaching staff and recommendations on programming process.

Data Analysis

Content analysis method was used for analysing the data in this study. The data obtained from observations, interviews and the written forms were analysed and presented together with the citations. In qualitative research, validity is ensured by transferability, confirmability, dependability and credibility standards (Merriam, 1998). To provide transferability; the study group, environment and processes are described in detail. Also the data are presented in detail for similar studies. For the credibility, observation notes and audio recordings were compared to correct missing or misunderstood points. Besides, data were diversified for credibility. To ensure reliability; the implementation environment was described in detail, photographs were taken, audio recording was kept, and data collection and analysis methods were explained. In addition, the data was submitted directly without comment, and that the interviews, observations and form data are consistent with each other. The researcher is the participant as observer role in the implementation process. The researcher took detailed notes in the process and rechecked this data with voice recordings.

Procedure

The procedure of this research is summarized in Figure 1.

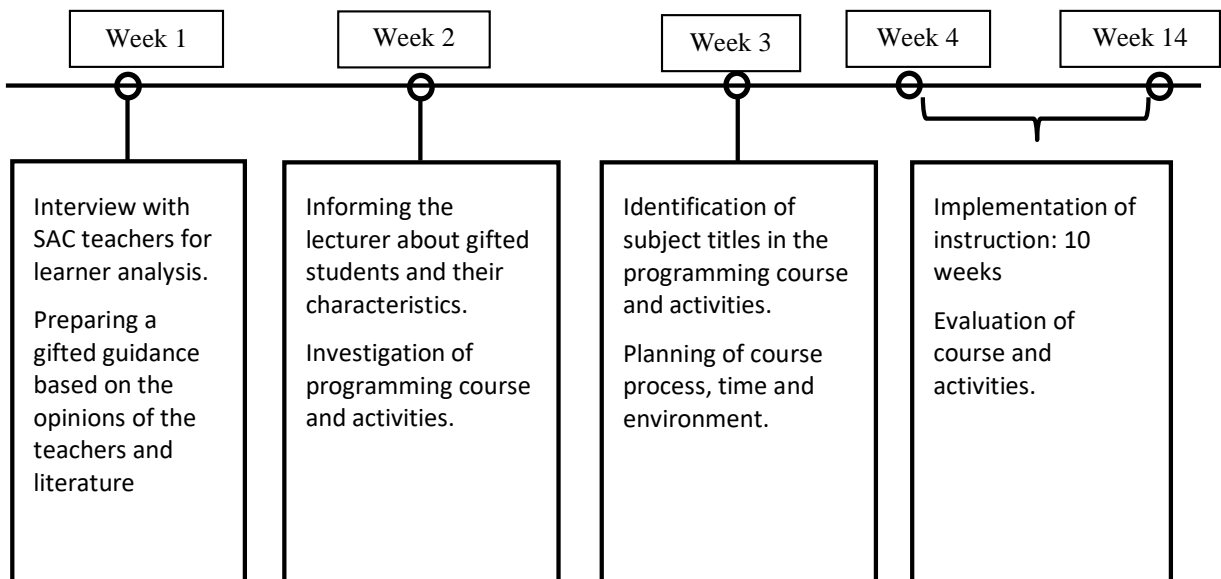
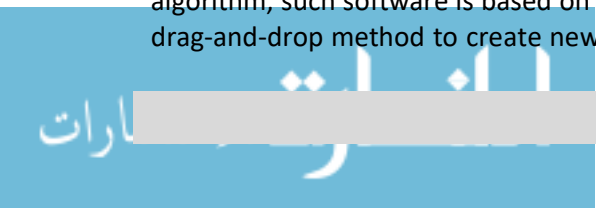


Figure 1. Research process

During the first week of the study, SAC teachers were interviewed for the learner analysis. During week two, the lecturer was informed about gifted students and their training in the direction of the analysis of the learners and the literature review. In addition, the software trainings given to gifted students were examined. Next week; the procedure, schedule and environment were planned. Then ten weeks' implementation started. During the teaching process, data were collected through observation, written opinion forms and interviews. After the programming course, a semi-structured interview was held with the lecturer to evaluate the process.

Identifying the Programming Environment and Topics

Available programs and implementations for programming were analysed in this research. Today, there are many educational programming platforms (Alice, Scratch, Microsoft Small Basic, Toontalk, Code, Stagecast Creator, KhanAcademy etc.). Basically aiming at facilitating the instruction and programming of the algorithm, such software is based on the principle of combining the visual tools or the code blocks with the drag-and-drop method to create new programs. Above mentioned visual programming environments have



features of providing an entertaining learning process by (Sáez López et al., 2016), attracting attention and facilitation (Schwartz et al., 2006) by increasing student motivation. We decided to use Scratch particularly in this study. Because it has intuitive user interface and provides several blocks that can be used to handle graphic images and sound clips out of the box (Lee, 2011). Another strength of Scratch is that blocks fit together only when they are syntactically correct. It also is an open-source media-rich programming environment that provides a social computing network for users to share their projects. Users can share their project online with Scratch. Also, Scratch supports multiple languages and simultaneously displays the stage, sprites, and scripts (Lee, 2011).

In this study, programming trainings given to gifted students were examined. It was observed that the trainings for the programming were given in summer or winter camps and at technology workshops. At the same time, programming trainings for gifted students carried out by experts in children's universities. Examples include Istanbul Children's University, Mehmet Akif Ersoy Children's University and Istanbul Aydın University in Turkey; and Calvin University, iD Tech Academy and John Hopkins University Center for Talented Youth abroad. Scratch program was widely preferred in these trainings because of above expressed features. Table 2 presents the topics and programming activities.

Table 2. Topics of the programming course

Week	Topic	Activities
1	Meeting; Algorithm	Addressing questions (student expectations, their readiness levels, interests and goals) Providing and asking students for examples for the question "What is Algorithm?" Outlining the algorithm of a process in everyday life
2	Algorithm Scratch presentation Using Objects Variable definitions Condition Structure Character operations	Discussion on the concept of algorithm and algorithm logic Introducing the Scratch interface Step progress of the character when clicked Identify the x and y coordinates of the character Controlling character from the keyboard Checking the values entered from the keyboard Determining whether the entered number is greater than or less than 10
3	Defining variables Character operations	Getting the character move to the place where the mouse is clicked Being able to perform arithmetic operations with numbers entered from the keyboard The movement of the character with the keys entered from the keyboard and the change of the costume at the same time.
4	Variable definitions Condition Structure	The character jumps when it meets an obstacle Writing the program that finds the number entered in the keyboard greater than, equal to, or less than zero, Writing the program that finds the number entered in the keyboard even or odd.
5	Character operations Loops Condition Structure	Writing the program that finds the largest and smallest of the numbers entered from the keyboard Writing of the program that enable the character to progress at the same time as moving upwards when the up key is pressed
6	Loops Condition Structure	The program that finds the Fibonacci array element corresponding to the number entered from the keyboard, a prime number sequence
7	Project: Packman	Preparing the game background Creating the characters

		Animating the main character
8	Loops	Preparation of the outer obstacles in the game
	Condition Structure	Designing the target point
9	Character control	Featuring the character and the game with sound
	Variable definitions	Creating the collection of points and the status of losing rights
10	Using Objects	Creating intermediate target objects for the character
		Designing the game finishing window

In Table 2; during the first week, after the orientation, the students' ideas and logic of the course were discussed. In the second week, the algorithm logic was continued and the Scratch program was introduced. Between the third and seventh week of the implementation, various activities were carried out particularly for mathematical operations and character control in the Scratch. From week seven to ten, Packman game was designed on Scratch as a container project.

Implementation Environment

The implementation was conducted in a classroom with wireless internet-connected computers for students to work individually. The classroom also has an interactive board. The class was designed with U-shape, and images are given in Figure 2.

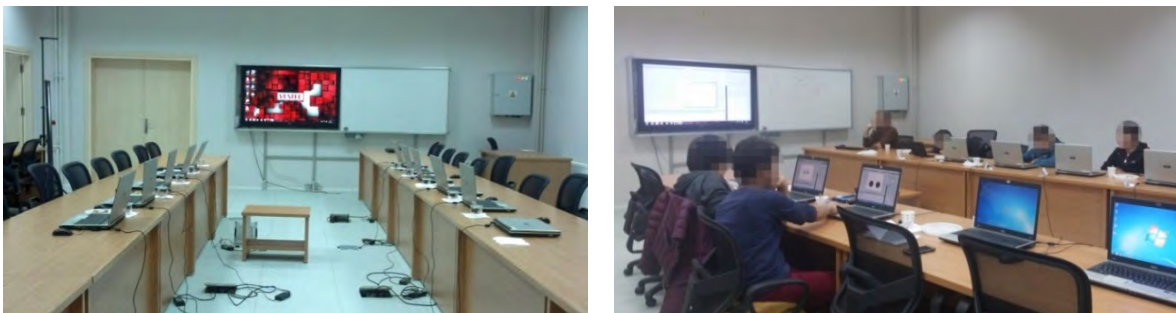


Figure 2. Implementation environment

The interactive board was used effectively by the lecturer in order to give information about the program, to develop the implementations and to make the activities.

FINDINGS

The lecturer's notes, opinions of SAC teachers, observation notes and opinions of the students were taken into account as this question. Table 3 summarizes the data collected under the headings of the course duration, number of students, activities to be carried out during the course, and out of school activities.

Table 3. Views of teachers, students and lecturer on planning of the teaching of programming to SAC students (+: Agree, -: Disagree, N: No views)

		Course Duration			Activities			Out-of-school activities		Number of Students		
		Flexible course duration	Keeping Duration Long (Activity +Break)	Higher Level Activities	Brief Examples	Project-Based Modular Works	Specific Works for Interests and Needs	Game Based Works	Specific Works for Interests and Needs	Specific Independent Works	Individual	Group Work
Teacher	T1	+	+	+	N	+	+	N	+	+	+	+
	T2	+	N	+	N	+	+	N	+	+	-	+
	T3	+	-	+	-	+	+	N	+	+	+	+
	T4	+	+	+	+	+	+	N	+	+	+	+
Lecturer	P1	+	-	+	-	+	+	+	+	+	+	-
Student	S1	N	N	N	N	N	+	+	+	N	N	N
	S2	+	N	N	+	N	+	+	+	N	N	N
	S3	+	N	+	N	N	+	+	+	N	N	N
	S4	N	N	N	N	N	+	-	+	N	N	N
	S5	+	N	+	+	+	+	+	+	N	N	N
Observer	G	+	+	+	-	+	+	+	+	+	+	+

In Table 3; most of the participants pointed out that in the programming training for gifted students, the interests and needs of the students should be taken into consideration and the process should be flexible. Teachers stated that project-based learning can be done. They also emphasized that individual or group work should be at disposal of the students. The lecturer opinion and observation notes suggested that courses should have flexible duration, the activities should be project-based and game-based, the decision should be made together with the students on out-of-school works, and individual education should be provided if possible.

In programming course; the lecturer, SAC teachers' views, students and observer data support each other. The headings in Table 3 are explained below.

Course Durations

All of the SAC teachers ($f = 4$) stated that course duration should be flexible considering student interest. Yet, they stated that it would be appropriate to set general time limit for the courses. With regard to course duration, T3 said "Sometimes we keep teaching and learning nonstop for 80 minutes with a high level of interest. But in some courses they're bored in the first ten minutes".

The duration of the course was set as an hour before the implementation but it was flexible depending on the student interest. In the interview, the lecturer said that the duration should be long and flexible enough "for gifted students to be able to do their individual works in the programming training". According to the findings of the "Programming Course Evaluation Form", duration of the course should be adjusted according to the students' interest in the course. On this subject, student S5 said "Course durations can be flexible; we can have lessons as we want, and then take a break when we get tired." Another student with code S3 said "I wish the implementation continued because the teaching hours were not enough for our implementation."

Activities

The interview with SAC teachers revealed that the students need high level and practical activities ($f=3$). In this regard, the view of the teacher T1 is as follows:

"They don't enjoy much being a listener, you must have hands-on activities."

In the process, short activities for mathematical operations and character control were made up to 7th week. When observation findings were examined, it was seen that the students except for S1 and S2 were silent and had less attendance during the short activities. During the interview in fourth week, the lecturer stated that the mathematical operations were continued but their interest level was low. The opinion of lecturer is as follows:

"We can continue for the solution of mathematical equations and developing the algorithmic thinking skills. They did not show much interest this week. I do not really know if the students do not answer despite noticing, or they are really uninterested."

On the second, fourth, sixth and eighth week, semi-structured interviews were conducted with the lecturer in order to evaluate the teaching program; after the implementation, semi-structured interviews were held to evaluate both the training program and the students. On the second week, with regard to the gifted students "The students are different from regular students and one other. I don't understand exactly what they are doing in class" said the lecturer. On the fourth week, it was stated that the students did not endeavour to show the activity accomplished like the regular students to the lecturer. For this reason, the students' motivation cannot be determined exactly by the lecturer. On this subject, the lecturer said "Students answer questions when asked. They have no desire to answer if they are not asked. It's quite difficult to understand what they are doing except for this". Nevertheless, even though they seemed not to listen to the lesson, they responded to the question when they were asked to do so, which indicates that they were in fact following the lesson.

According to the written opinion of students on the fifth week, they have positive opinions about the programming course. Some students stated that they wanted to program a game. Student S1, S3, and S5 opinions are below:

S1: "I think it's going well, the lesson is not boring. It's usually fun".

S3: "The Maze game we made in the lesson was very good."

S5: "S5: I am happy to be here. Lessons are fun".

The data obtained from the written opinion of students on week 6 demonstrate that character control seems to increase student interest. Sample student expressions related to the subject is as follows:

S1: "It was fun to write the codes by applying to real life".

S5: "It would be better if the applications are related to the movement of characters like Maze and Mario."

In the interview with lecturer, it is stated that since the packman game was programmed, the students' interest increased and attendance increased, while participation in the programming of mathematical operations in the previous weeks had been much less. This is supported by observation notes. It was observed that the students made an effort to develop their projects by doing research on the internet related to the Packman.

In the semi-structured interview, lecturer was pointed out that student interests and needs should always be taken into account when planning the course. It was emphasized that the students' motivation and attendance were generally high, but the motivation increased further upon starting to program games. The lecturer said as follows:

"We had students like S2 who were very interested and motivated throughout the process. The students like S4 also became interested students afterwards."

The opinion of the lecturer about the programming process is as follows:

"Once the basic information is given, it is better to step into the parts of a major project. I see this different from conventional teaching because this is not the case in conventional teaching. In programming teaching, there is the from part to whole approach. But I think that it would be more effective in the education of these students to create a project in which all of the students would break apart and then merge into a single point. In addition, the project topic can be set freely by the student to ensure minimum conditions."

As understood from the lecturer's expression, providing project-based learning to gifted students, unlike other students, may be more effective for the programming lesson. Apart from this, there was a marked increase in student interest and attendance as a result of switching from mathematical operations to character control and game programming.

Observations made during game programming indicate that the motivation of the students was higher than the previous week. Particularly, S4 and S5 showed a significant increase in desire for participation in the lesson. The students made an effort to bring new characters to their games. During the unstructured interview, the lecturer noted higher student interest in the activities related to the character control and the game. The opinion of the lecturer about the subject is as follows:

"Implementations involving visual items are attracting more attention. At first we went on the algorithmic modelling of mathematical problems, but with the game more attention was paid to the teaching."

Lecturer's views and observation notes that project-based activities in the game-based implementations could increase student interest and motivation.

Out-of-School Works

According to the findings of the interviews with SAC teachers, extracurricular assignments should be decided together with the students ($f = 4$). Teachers said that the students are doing research and practice without being assigned homework on a topic when they are interested in. Also it was stated that students sometimes do not study because of the lack of anxiety about points in the support trainings.

Observation findings indicate that extracurricular assignments were carried out after they started Packman game programming. Gaming programming arose interest and curiosity among the students. In the post-implementation interview, the lecturer stated that students' views should be taken into account for the out-of-school activities to be assigned, and that the assignments should be independent and flexible in such a way that they can manifest their own creativity with certainty of the topics.

Number of Students

The implementation was carried out with five students in programming teaching. This number did not create any difficulty during the teaching period according to the observation findings and views of the lecturer. But faster progress and success was recorded in individual teaching. The 4th unstructured interview with the lecturer was conducted on the 8th week of the practice. The 8th course was conducted with one student because the other students could not attend. In the end of this course, the lecturer emphasized that the teaching was more effective then. The lecturer's statement is given below:

"It was really good that the student was S1. That student is really capable of this. He found the English version of my application on the internet and transformed it from there. It may seem like a citation, but there is no problem in understanding the logic. The basic logic seems to be well-understood. Conditionals, operation steps, and cycles are well-understood. These are already the basis of the algorithm. Individual lessons with these students can give much more successful results than group work."

Observational findings also support this situation. In addition, S1, participated in the lesson after preparation, utilizing the sources from the internet about the game adding innovations to the game as a result, was regarded important by the lecturer.

Lecturer and Students' Opinions

The lecturer stated that the students showed affective behaviours compliant with their age did not see any significant difference. As to their consciousness of task, the lecturer pointed positive views by saying "these students can sense whether they need the topics covered, and they fulfil the tasks assigned to them if they think it will be useful".

With regard to the students' communication skills, the interview explained that they are not brilliant and they also may be experiencing difficulty in expressing themselves by saying "students will not answer or communicate unless they are addressed a question; they are not concerned about showing themselves, so they don't communicate much. They do not participate much in non-lecture discussions, either. Students do not share many of their opinions verbally".

In relation with the students' reactions in the course, it was said "Students want to do the job they have been curious about and interested in. They focus and want to solve it as they are interested in something. However, the task to be assigned should take that student one step forward or arouse wonder. Otherwise, they do not get into the subject much. They have capacity for dealing with more than one thing at one time because they are able to learn faster than normal".

The written opinion findings are presented in Table 4 on the basis of expectation satisfaction, teaching of the lesson, in-school activities, learning environment, instructional staff and expected remedies.

Table 4. Students views on the programming training (+: Agree, -: Disagree)

Theme	Code	S1	S2	S3	S4	S5
Satisfaction of expectations	Sufficient	+	+	+	+	+
Teaching of the lesson	Fun and useful	+	+	-	+	+
	Could be faster	-	-	+	-	-
In-school activities	Game was so good	+	+	+	-	+
	Practices were instructive	+	+	+	+	-
Learning environment	Comfortable, large, technologically rich, spacious	+	+	+	+	+
Lecturer	Convenient teaching methods	+	+	+	+	+
Expected Improvements	More time should be spent on programming games	+	+	+	-	-
	A little more time should be spent on mathematical examples	-	-	-	+	-

Table 4 displays that the programming offered to the gifted students met the expectation of all of the students. Another striking finding is that three of the students hold the view that the programming should be given by game programming. Sample student expressions regarding the subject are as follows:

S3: "We made games in the lesson. The practice of the labyrinth game was very good".

S4: "There should not be much computation operation. For example, mathematics sounds boring to me. It was much better for me to design a game".

S5: "I'm happy to be here. The lessons are really fun. I can design a sort of game I want thanks to this knowledge".

It is inferred from the students' opinions that the training could satisfy the expectations, teaching method and the teaching environment were appropriate:

S1: "I think I have learnt the algorithm logic. It met my expectation".

S2: "It met my expectations because I accepted the logic of the algorithm and it was what I wanted. I wish the lessons continued".

The students generally expressed positive opinions regarding the programming training and activities.

DISCUSSION AND CONCLUSION

In this research, we offered suggestions regarding designing of programming course for gifted students. Priority was given to the SAC teachers who provided support to gifted students for their recognition. In the results of the interview, the lecturer who offers the programming was informed about the students. The course process was planned with the lecturer for 10 weeks, by taking into consideration the applications in the literature as well as opinions of the teachers. Scratch program was used in the training process. Scratch is valuable tool for gifted students because it enhances their problem-solving and logical thinking skills. It also could enable gifted students easily learn the abstract knowledge of computer programming (Shukla, 2019; Siegle, 2009;). The tools provided in Scratch allow gifted students to study independently or in collaboration with community members (Hagge, 2017). Sources of data included interviews as well as observations and forms. The data were discussed under headings such as student characteristics, activities, out-of-school works, number of students and course durations. The results of the research were evaluated under relevant headings.

The findings in the study suggest that it is necessary that the programming curriculum and activities for the gifted students should be very flexible and can be shaped according to the student characteristics. According to Reis and Renzulli (2009), instruction designers do not prepare a detailed set of lesson plans or unit plans in advance for enrichment clusters. Instead, the enrichment cluster should be guided with 3 questions as “What do people with an interest in this area (e.g., film making) do?, What knowledge, materials, and other resources do they need to do it in an excellent and authentic way?, In what ways can the product or service be used to have an impact on an intended audience?”. Also the literature reveals that gifted education should be planned in a way to enhance their interests and abilities by taking into consideration the learning environment and services they need (Davis & Rimm, 2004).

In the study, programming course was carried out for 10 weeks, one hour per week. This time was not enough for the class time. In a study by Wang, Huang and Hwang (2014) which offered project-based Scratch training to gifted ones, instructional process consisted of 12 learning sessions, each of which lasted 50 minutes. Usually, though, clusters are offered during an extended block of time from one hour to one-half day per week for as long as interest remains high (Elliott et al., 2013). In the scope of teaching of programming to gifted students, weekly classroom hours should allow the students to practice individually. Regarding time of enrichment program, some expressions such as appropriate pacing, proper pacing, and flexible time are used (Sousa, 2009).

It is concluded that the programming training has been sufficient for the students to gain the basic programming rationale. Classical programming process refers to the writing of the program that performs mathematical operations and the small applications in which the character is animated. In game programming process, Packman game was programmed. From the motivational point of view, the motivation of the gifted students in the classical programming activities was high. In the literature, it is stated that presentation of programming instruction with visual programming has a positive effect on motivation (Sáez López et al., 2016). Moreover, our study revealed that game programming increases the attendance and motivation of the gifted students in the classroom. The literature also suggests that game design is motivating for learners of programming (Claypool, 2013) and encourages them to program (Kazimoglu et al., 2012). Theodoraki and Xinogalos (2014), gave simple games such as Snake or Tetris to the participants in their programming lessons and then asked them to expand these codes by analysing the codes of these games. It has been found that the motivation of the students increases and in this way the complicated concepts are understood more easily. Mathrani, Christian, and Ponder-Sutton (2016) stated that active learning could be achieved by presenting game programming and traditional applications together. The game development activity supports gifted students' problem solving skills and offers students the opportunity to convey their thoughts into the game (Hava et al., 2020).

Another result of this study is that the students have higher motivation in game programming than the character-based activities in the classical programming process. Thus, it is thought that working on projects rather than piecemeal activities may increase motivation. Sáez López et al. (2016) refer to the motivation-enhancing effect of working on projects in the visual programming environment. From the perspective of programming success, students were successful in mathematical programs during the classical programming process. In addition, the transfer of mathematical operations into the programming environment also facilitates the understanding of mathematical concepts (Calder, 2010). In the game programming, students have achieved higher success. This is thought to be related to increased motivation. Wang et al. (2014) stated that project-based learning on Scratch program increase student motivation and success. Another finding in the literature suggests that game programming encourages students to program (Kazimoglu et al., 2012), and accelerates problem-solving skills of students (Chang & Biswas, 2011).

The study suggested that gifted students can be assigned with homework to develop skills as a part of teaching programming. However, it is recommended that these assignments should be decided together with the students. These students are also working out school without being assigned any homework. Otherwise, they do not fulfil the duties on topics that are not interesting or appealing or repetitive after the class (Strip & Hirsch, 2000).

The research revealed that individual programming was more effective than group education of gifted students. Furthermore, the fact that the students were a mixed group of different age levels did not cause any problems in the education process. This implies that making requirement groups rather than age groups is more appropriate in the programming training of the gifted. According to Reis and Renzulli (2009), *“enrichment clusters are non-graded groups of students who share common interests, and who come together during specially designated time blocks during school to work with an adult who shares their interests and who has some degree of advanced knowledge and expertise in the area. In the training of gifted students, students can work individually or in groups of 4-5”*. In this respect students should be given the choice (Smutny, Walker, & Meckstroth, 2000). According to another research, cooperative learning is less positive effect on gifted students than the others (Elliott et al., 2013). In relation with training of gifted, the concept of "flexible" comes to the forefront in the literature. Teacher, in creation of the physical environment, selection of the materials, identification of the groups and preparation of the lesson plan, should act in compliance with the idea of “flexible”. Individual or small group work can be done through flexible grouping during teaching (Renzulli & Reis, 2013).

The results of the research summarized in general as follows. In the context of programming training;

- The use of Scratch seems appropriate for gifted students aged between twelve and fifteen.
- The length of the course should be flexible depending on the students.
- In-class activities should be presented in a project-based context.
- The number of students in the working environment should be as small as possible. Individual characteristics of gifted students who differ in intelligence types should be considered. For this reason, individual training could be more effective in teaching programming.
- Students' views should be taken into consideration when gifted students are given homework assignments.
- Game programming increases motivation and participation in class.

Some limitations of the present study should be noted. A main limitation of this study was that instruction period was 10 weeks. This period can be applied as a school year. Also, student products were not evaluated within the scope of the study. Project-based holistic studies can be done in the programming trainings presented to the gifted students. Another limitation is that the research focuses only on the learning-teaching process. Different dimensions such as motivation, academic achievement and self-efficacy can also be considered. Effect of game design to motivation can be research. Content of course should be presented to the gifted students considering their interests. Training process should be kept flexible and educators informed about the characteristics of these students. At universities should offer support training to gifted students in their respective areas of interests. In future research, the effect of game programming on skills such as problem solving or creative thinking can be explored.

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