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Development of a computer program for the identification key to insect orders (Arthropoda: Hexapoda)

Gökhan Aydın [a] *, Volkan Duran [b], Hüseyin Mertol [c]

[a] *Isparta University of Applied Science, Atabey Vocational School, 32670, Isparta, Turkey*
[b] *Iğdır University, Şehit Bülent Yurtseven Campus, 76000 Merkez/Iğdır, Turkey*
[b] *Gaziosmanpaşa University, Geography Department, Campus , Tokat, Turkey*

Abstract

This study aims to develop a computer program for the identification key to insect orders (Arthropoda: Hexapoda) and to investigate its effectiveness as teaching material. Secondly, this study is aiming at whether this program improves students' computational thinking skills or not longitudinal quasi-experimental design. Firstly, the study is based on a longitudinal design involving repeated observations of the same variables over long periods and it is a repeated cross-sectional study also. Secondly, this study is based on a quasi-experimental design. According to this, there are two main groups selected for the study as the ones who took the course and the ones who didn't. There are two subgroups in those groups also the ones who identify the insects by dual diagnostic key and the ones who use the computer program developed by the researcher based on the dual diagnostic key. The population of the study consists of 621 students who took the courses related to entomology and 470 students who didn't take the course in the education period of 2010-2020 summing up 1091 students in total. The first indication of this study is that the computer program developed for the identification of insects is very effective for the students who took the course comparing the one using a classical method for the identification of insects. The second indication of this study is that the computer program developed for the identification of insects is very effective to improve the computational thinking skills of the students in terms of abstraction, automation, data analysis, decomposition, pattern generalization, pattern recognition skills. Finally, it can be concluded that computer program used for the identification of insects is very effective irrespective of whether the instruction is taken or not.

Keywords: Identification key to insect orders, computational thinking skills, development of computer program

* Corresponding author: Volkan Duran
E-mail address: volkan.duran8@gmail.com

1. Introduction

1.1. Introducing the problem

New tools were discovered in our evolving and changing world every day to make human lives easier. These findings and innovations lead to problems we never had before. However, to use these inventions, new qualifications and skills are also required. Computational thinking skills are among those kinds of skills that are required for today's daily life problems because computers are everywhere from the kitchen to work fields. According to Wing (2006), computational thinking can be defined as problem-solving, system design skills by using the concepts of computer science. Computational thinking is a way of thinking that uses processes related to algorithmic thinking, abstraction, parallel thinking, and matching (Czerkawski and Lyman, 2015). Computational thinking is to have knowledge, skills, and attitudes that can use computers to produce solutions to problems in our lives (Korkmaz et. al. 2015). Although this concept, standing for in the 1950s and 1960s as algorithmic reasoning, is now defined as a broader notion, the idea is used as a cognitive procedure for transforming certain variables into outputs and a cognitive direction, creating models to formulate issues and transformations (Denning, 2005). According to Özkan (2003), the algorithm is a set of consecutive steps that can be used for defining a final task which can be obviously and simply specified and performed. In this context, considering that algorithmic thinking is based on algorithmic thinking skills, the main computational thinking skills are given as abstraction, algorithm design, automation, data collection, data analysis, data representation, decomposition, parallelization, pattern generalization, pattern recognition, and simulation.

Computational thinking is a rapidly developing skill that is likely to contribute to personal and social development and generate significant gains for national economies, such that managers, software companies, and educators of countries strive for computational thinking (Çatana Kuleli, 2018). Although computational thinking in all countries - such as Germany - is not seen as a core area in-school programs, computational thinking is encouraged in many countries, such as Israel, England, and the United States, or taught to students as compulsory courses (Çetin and Toluk Uçar, 2017). The computational thinking of problem solutions, therefore, affects all disciplines and they become a fundamental skill that can be used by everyone in many areas, such as mathematics, science, cultural studies, and management (Bundy, 2007). Therefore computational skills are of significance for biology, more specifically for - identifying insects.

In this study the effectiveness of the computer program has been examined for 9 years as well as its effectiveness for computational thinking skills. In this regard, it was investigated that abstraction, automation, data analysis, decomposition, pattern generalization, pattern recognition skills because students used abstraction for identifying and extracting relevant information to insects, they used also automation for doing repetitive tasks in the computer program, they used data analysis making sense of data regarding insects by finding patterns or developing insights, they benefited from decomposition, pattern generalization, pattern recognition skills to break down data regarding, processes, or problems into smaller, manageable parts so that is they models, rules, principles, or theories of observed for observing patterns, trends, and regularities in data.

To summarize, computers have become the main part of education in every aspect of the educational process. Hence, it is indispensable to benefit from computers to facilitate the teaching and learning process. However, rather than pure deductions, new experimental and longitudinal studies are needed to assess whether computer or algorithm-integrated curriculums are as effective as they were thought. In this study, a computer program was developed for the identification key to insect orders (Arthropoda: Hexapoda) to investigate its effectiveness as teaching material.

1.2. Relevant scholarship

When the literature is investigated, it can be seen that there??? are various studies. However, those studies can be viewed in terms of two dimensions where one is related to experimental and action designs and the other is related to survey designs.

In terms of the experimental and action designs, studies investigated how a particular curriculum or program affects computational thinking skills. For instance, Üzümcü (2019) found that there was an increase in the computational thinking skills of prospective teachers. They indicated that their problem solving, questioning, analytical thinking skills developed in the program design for computational thinking skills. In another study on preschool education related to computational thinking, a program on preschool coding education was developed (Patan, 2016). In this study, which aims to improve the computational thinking skills of children between the ages of 4 and 5, the coding curriculum was developed. The master thesis study, which investigated the effect of using robotics in computational thinking , was carried out by using an experimental design with 47 sixth-grade students (Yolcu, 2018). At the end of the 14 weeks, it was seen that programming education increased students' computational thinking skills but robotic use did not affect this skill. Kukul (2018) indicated that the students were more active and willing in the programming education process conducted based on real-life scenarios. As a result of the study done by Grover et. al. (2015) it was emphasized that the computational thinking skills of both groups developed but the students who conducted their courses with a blended learning approach showed more improvement in the research for a seven-week Scratch-based computational thinking course for 7th and 8th-grade students to improve algorithmic thinking.

In terms of the survey designs, studies investigated how computational thinking skills are related to other skills. Paf (2019) found that computational thinking skills and creative problem-solving skills differed significantly in favor of students who stated that they follow the developments in the field of technology. Similarly, it was found that the average scores of the students with computers are higher and the average scores differ in favor of the students who have computers. Çatana Kuleli (2018) found that a significant difference was found in general computational thinking skills and algorithmic thinking sub-dimension in terms of departments. The class level had effects on general computational thinking skills, creativity, and algorithmic thinking sub-dimensions favoring the fourth graders. In another master's thesis published in 2017, the relationship between mathematical intelligence and mathematics success was investigated (Oluk, 2017). When the relationship between the other mathematical intelligence and self-perception scale was examined, a positive correlation was found between them. Liao and Liang (2017) researched the effect of blended learning on students' computational thinking skills in their experimental research. They found that blended learning positively affected students' computational thinking skills in their mixed research using observation, text analysis, and scales for assessment. Denner et. al. (2014) conducted a study with 320 randomly selected middle school students, and it was found that cooperative students had higher computational thinking scores than individual employees.

When the literature is examined, it has been observed that there is a small number of studies examining the effectiveness of computer-integrated programs for the identification key to insect orders to investigate its effectiveness as teaching material. Therefore, this study contributes to the literature in terms of three aspects. Firstly, it contributes to the literature by developing a new computer program for the identification key to insect orders. Secondly, it examined the effectiveness of this computer program as teaching material. Thirdly, it examined also the computational thinking skills of the students in this respect.

1.3. Hypotheses and their correspondence to research design

The main aim of this research is to examine the effectiveness of a computer integrated program for the identification key to insect orders to investigate its effectiveness as teaching material. The main hypothesis of this study is that the computer integrated program for the identification key to insect orders can be used as effective teaching material for teaching processes. Therefore, there should be a significant difference between the performance of students who are exposed to computer technology and those exposed to the conventional method of teaching Biology.

In this research, three questions were sought given as

1- Are there any significant differences between the students who used the classical method and students who used a computer program for the identification of insects in the group of the students who took the courses related to entomology? This question was sought because it is aimed to reveal the effectiveness of computer programs by showing the significant difference between the students who used the classical method and students who used computer programs for the identification of insects.

2- Is there any significant differences between the students who used their intuition and students who used computer program for the identification of insects in the group of the students who didn't take the course? This question was sought since it is aimed to reveal the effectiveness of computer programs in terms of improving the computational skills of the students who used computer programs for the identification of insects.

3- What can be inferred from the effectiveness of the computer program in terms of both groups who took the courses and the ones who didn't? This question was sought because a general conclusion is aimed to be reached whether such a computer program is effective or not.

Therefore, in the analysis of the data, the independent-samples t-test or student's t-test which is an inferential statistical test that determines whether there is a statistically significant difference between the means in two unrelated groups was used for the analysis of the data because of the normal distribution of the data. In this respect, the study is based on a longitudinal quasi-experimental design to see how effective such a program over the years.

2. Method

2.1. Research design

This study is based on a longitudinal quasi-experimental design. The reason why it is longitudinal is that it involves repeated observations of the same variables over long periods. It is a repeated cross-sectional study where study participants are largely or entirely different on each sampling occasion (Caruana, et al., 2015) as seen in Figure 1.

In this study, the researcher was not able to randomly assign the participants to the classes designated as experimental and control groups. This is often the case in research in the field of education. As a result, the classes to be determined as experimental and control groups are randomly selected. In this case, the design adopted by the researchers is called quasi-experimental or non-equivalent groups (Cohen, Manion, and Morrison, 2005). According to this, there are two main groups selected for the study as the ones who took the course and the ones who didn't. There are two subgroups in those groups also the ones who identify the insects by a classical method or intuition and the ones who use the computer program developed by the researcher.

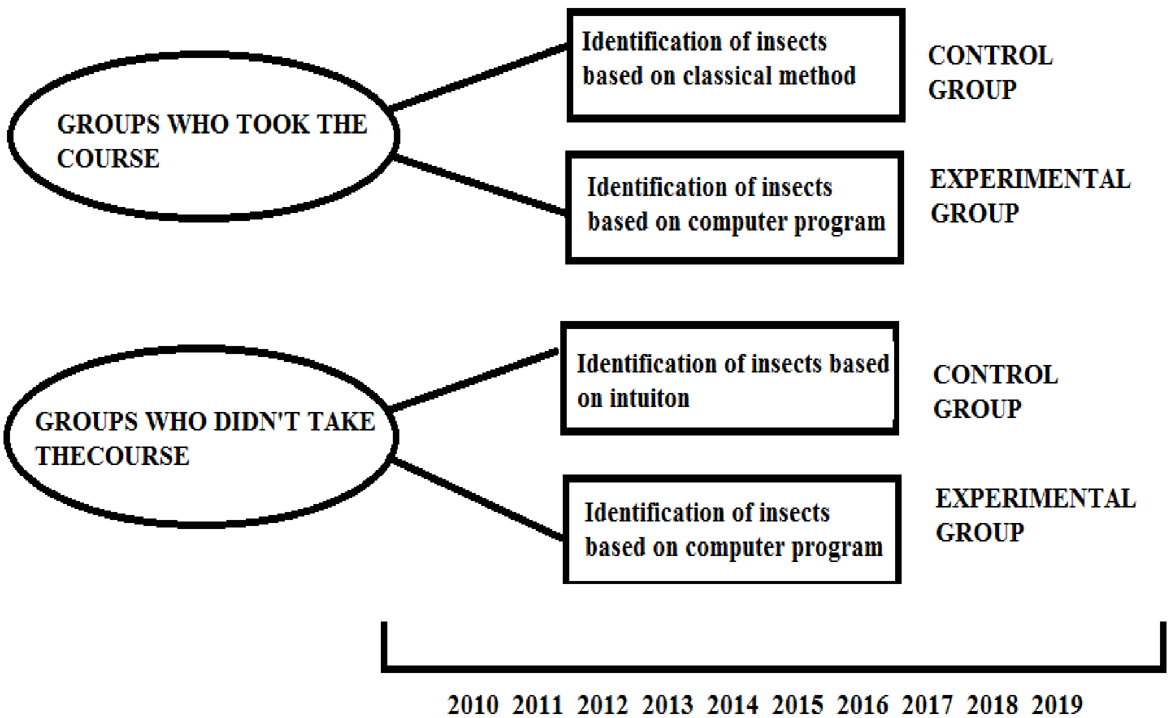

Figure 1. The longitudinal quasi-experimental design of the study

2.2. Participant (subject) characteristics

The population of the study consists of 621 students who took the course and 470 students who didn't take the course in the education period of 2010-2020 summing up 1091 students in total. The lesson consists of 10 weeks from two hours. All students are studied 20 hours for the insect classification lesson to the end of the term. The grade average of students is around 56 (over 100) and the average success rate is 68 % from 2010 and 2019 (Table 1).

Table 1. A grade average of the students (%) taking insect classification lessons between 2010 and 2019.

Year	Program Name	Number of Student	Grade Average (over 100)	Success Rate (%)
2010	Nursery Production	34	56,32	58,82
	Medical and Aromatic Plants Production	37	64,35	59,46
2011	Seeding	10	76,80	60,00
	Greenhouse	10	44.66	70,00
2012	Nursery Production	32	58,16	65,63
	Medical and Aromatic Plants Production	39	40,89	56,41
2013	Medical and Aromatic Plants Production	31	59,74	61,29
2014	Nursery Production	43	63,41	72,09
	Medical and Aromatic Plants Production	35	45,14	65,71
2015	Nursery Production	35	59,71	57,14
	Medical and Aromatic Plants Production	35	51,86	74,29
2016	Nursery Production	29	58,21	65,52
	Medical and Aromatic Plants Production	45	46,80	71,11
2017	Nursery Production	24	55,83	100
	Medical and Aromatic Plants Production	32	45,34	81,25
2018	Nursery Production	22	55,71	68,18
	Medical and Aromatic Plants Production	33	70	78,78
	Plant Protection	9	88,75	88,88
2019	Nursery Production	10	70,63	88,88
	Medical and Aromatic Plants Production	4	63,75	75,00
	Plant Protection	30	74,82	96,66
	Forestry and Forest Products	42	75,39	88,09
	Total students and averages of years:	621	61,03	72,87

2.3. Experimental manipulations or interventions

The intervention or experimental manipulations were used in the study by using a computer program for the identification key to insect orders. The computer program for the identification key to insect orders has been prepared for saving time, accelerate the identification process, to test and compare the success of students who take and don't take the lesson. The computer program consist of **7 main buttons**; about insects, dictionary of entomology, insect orders, user guide, start to identification, and exit on the main form (Figure 2).

Figure 2. The main form image shows 6 main buttons of the program.

The importance of insect information is given under "about insect button". This menu provides important information that is little known such as insect species richness and their diversity of the world. "Dictionary of entomology button" contains 414 terms in alphabetical order and an explanation about all terms needed for insect identification on the computer program (Figure 3).

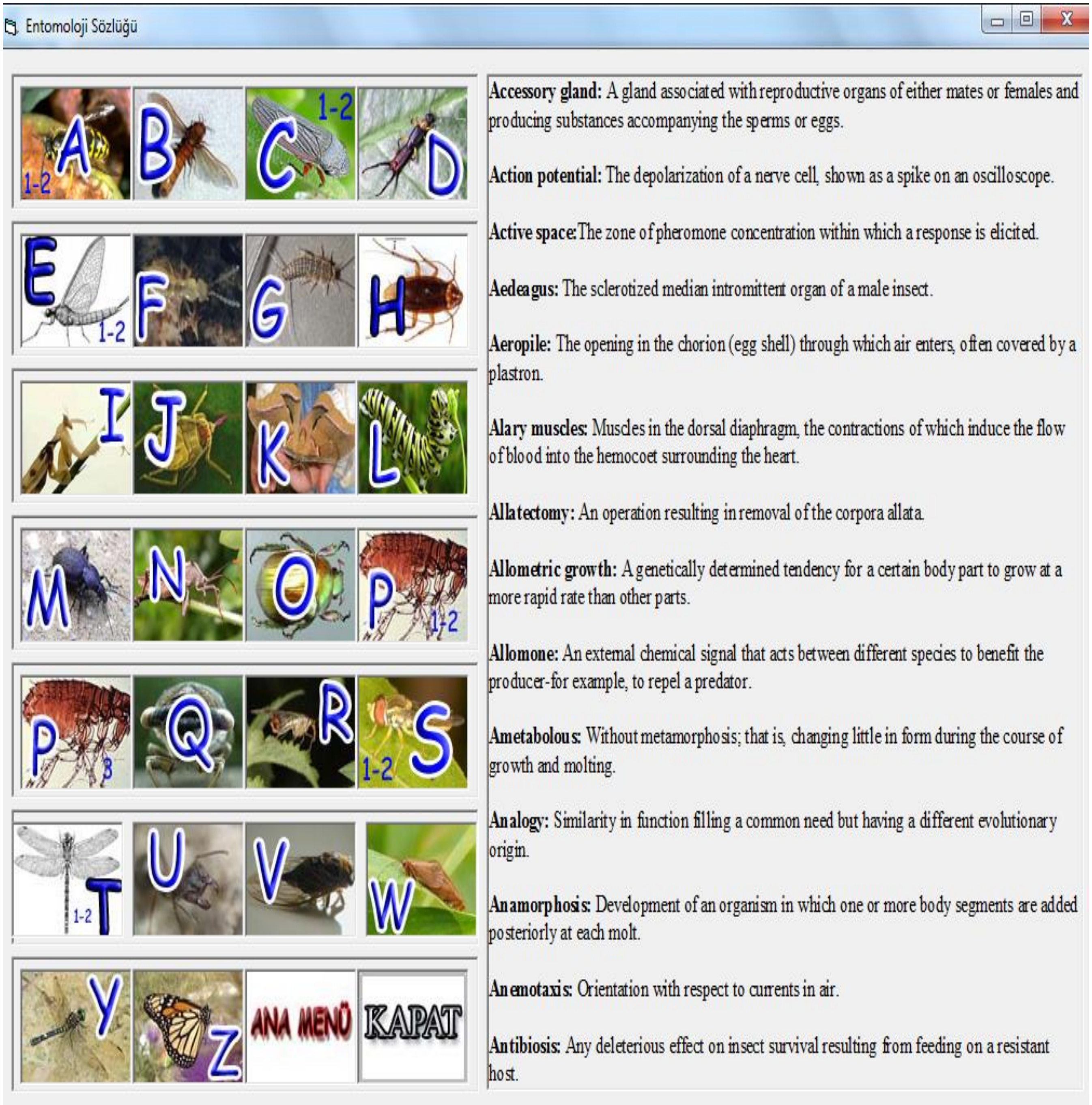

Figure 3. A sample of image and content of dictionary of entomology.

“Insect orders button” presents to users for direct access to the insect orders list (Figure 4).

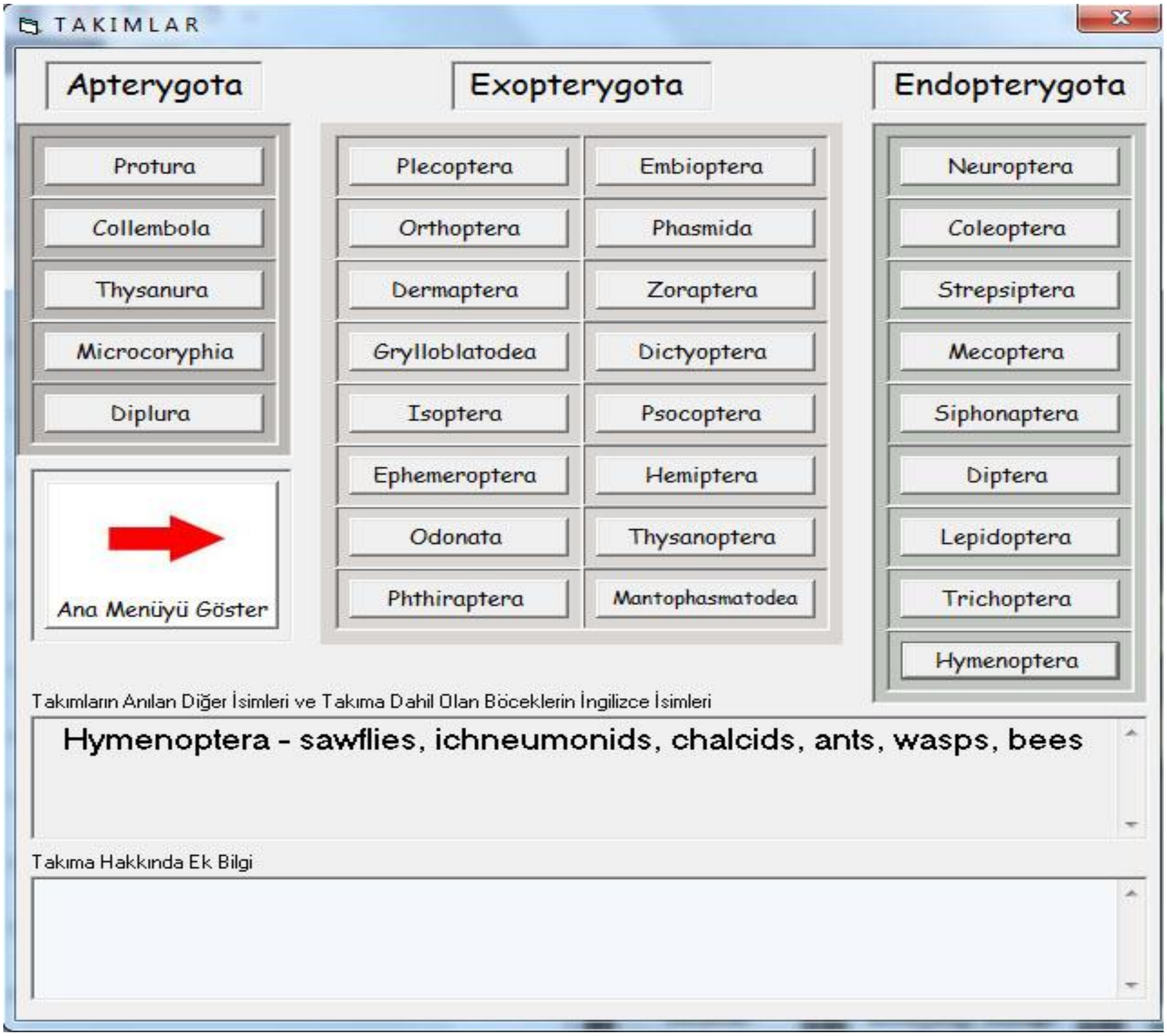

Figure 4. Insect orders list from the image. Providing for users access to insect orders list after clicking "Insect orders button" in the main menu.

A total of 30 insect orders are found under this mentioned menu. The users can directly access the insect order form from the Insect orders button. The "User guide button" provides information to users on how to use a computer program. Information of command buttons, text boxes, pictures, forms, and labels can be made available in the explanation text box after clicking (Figure 5).

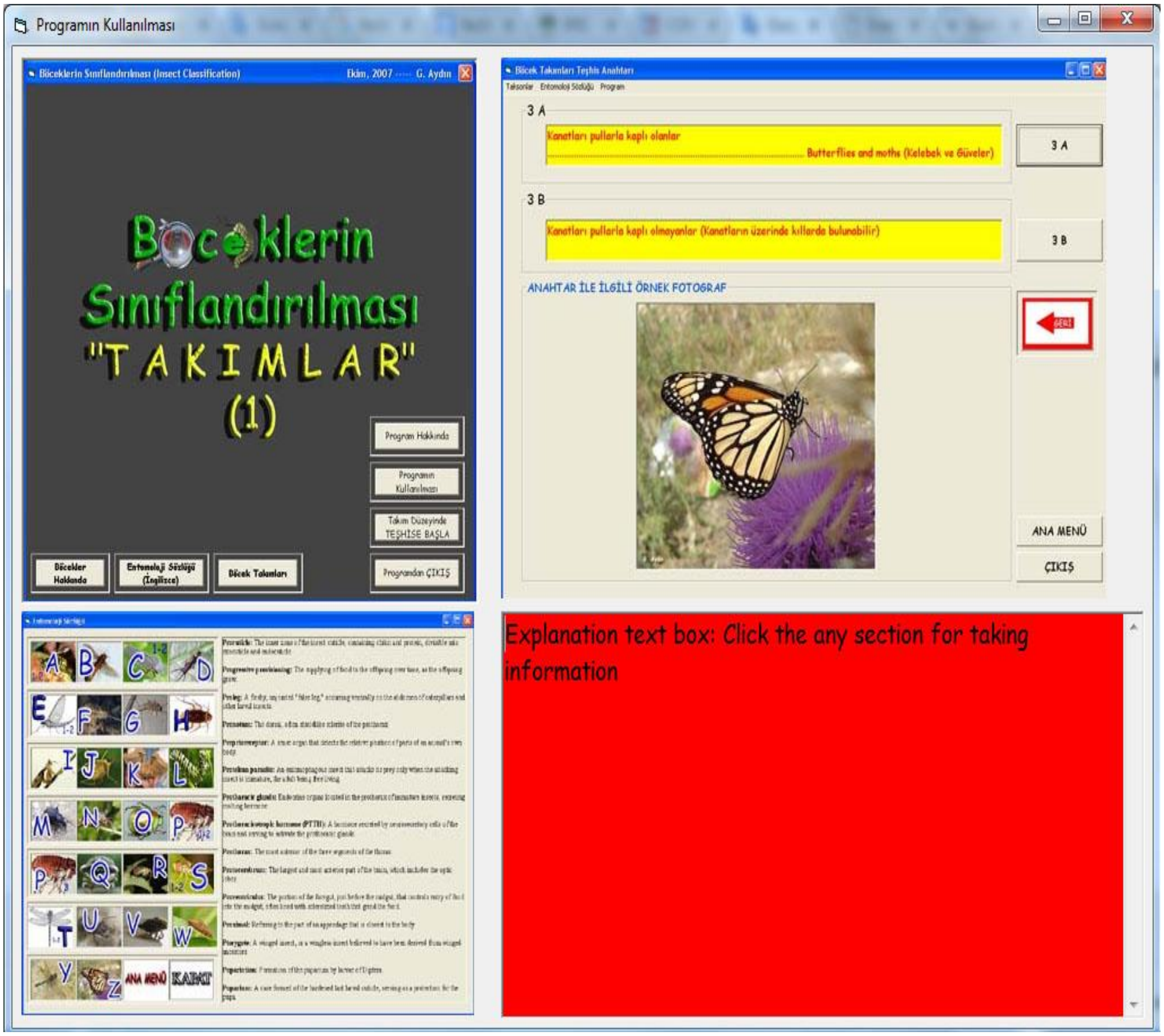

Figure 5. User guide form image

The “Start to identification button” must be clicked by the users to start the diagnosis. The users are directed through the questions with photos and/or pictures to identify insects as the order level. While the mouse encounter with related text box (yellow ones on Fig.6) the associated sample photo appears at the bottom of the image box.

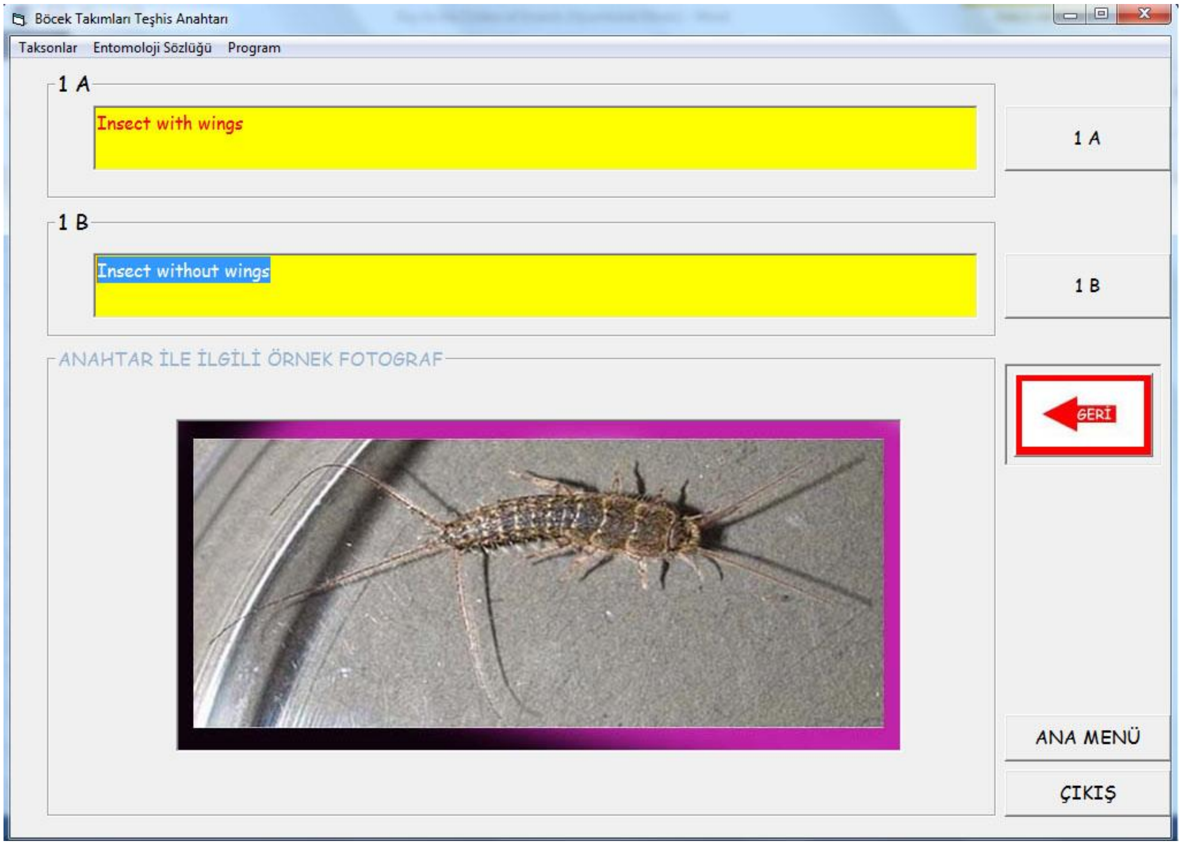

Figure 6. The first page of scientific insect classification key form.

The shortest path/step consists of 3 pairs of questions prepared for the Lepidoptera order while the longest one contains 17 pairs of questions prepared for both Phasmida and Mantodae orders. A total of 65 pairs of questions are presented for all insect orders and mentioned scientific insect classification key forms are supported with 130 photographs/pictures, 130 texts, 195 frames, and 325 command buttons. The order form according to the user responses to questions gives information for insect order about important features; physical features, life history and ecology, economic importance, as well as the photographs, metamorphosis, and following scientific insect classification key for related order are given. The program consists of 132 interconnected forms, including forms such as about insects, dictionary of entomology, insect orders, user guide, scientific diagnostic key, etc. A Diagram of the computer program between Q1 and Q26 is given as follows in Figure 7.

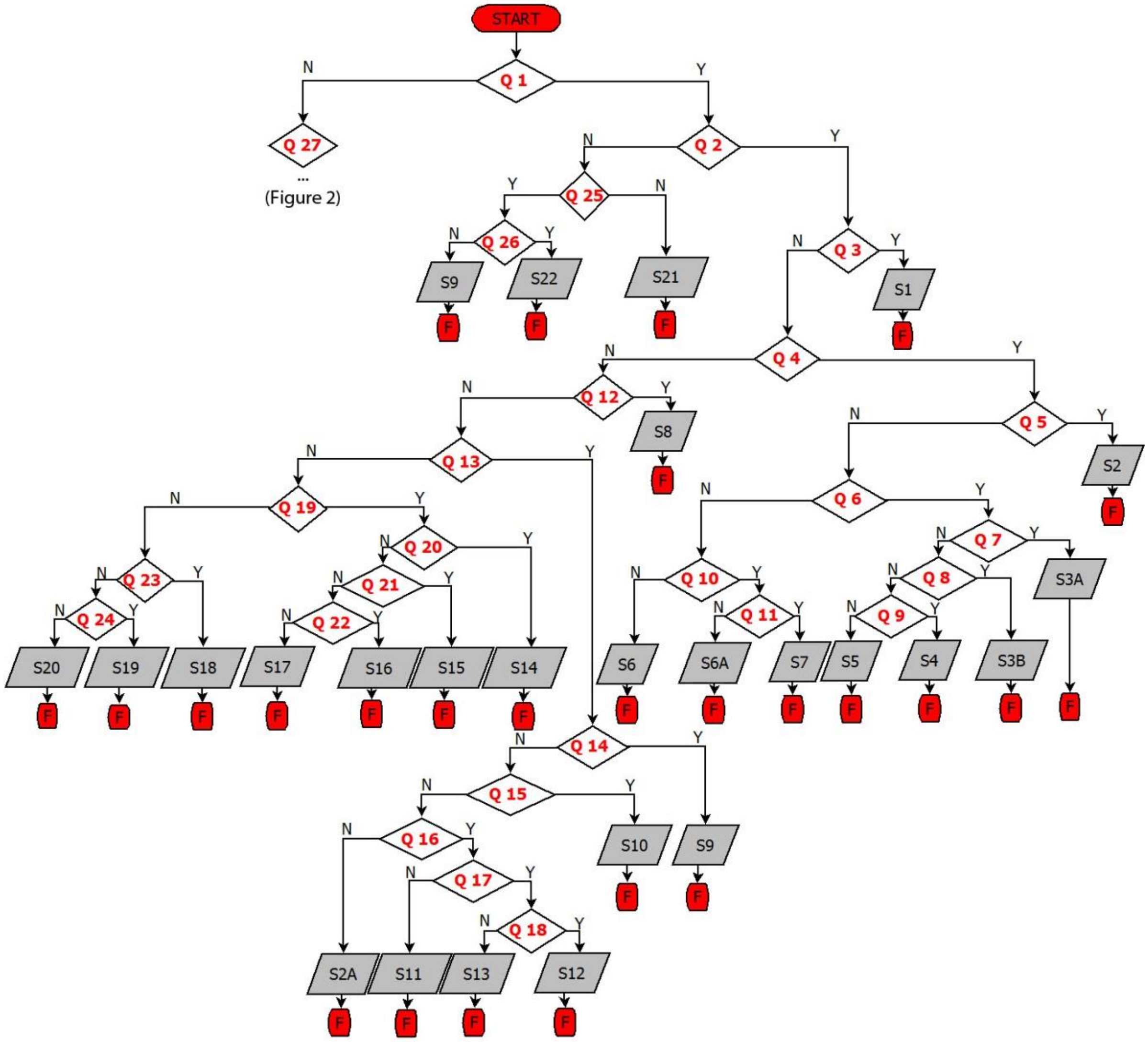

Figure 7. Diagram of the computer program between Q1 and Q26

A Diagram of the computer program between Q27 and Q65 is given in Figure 8.

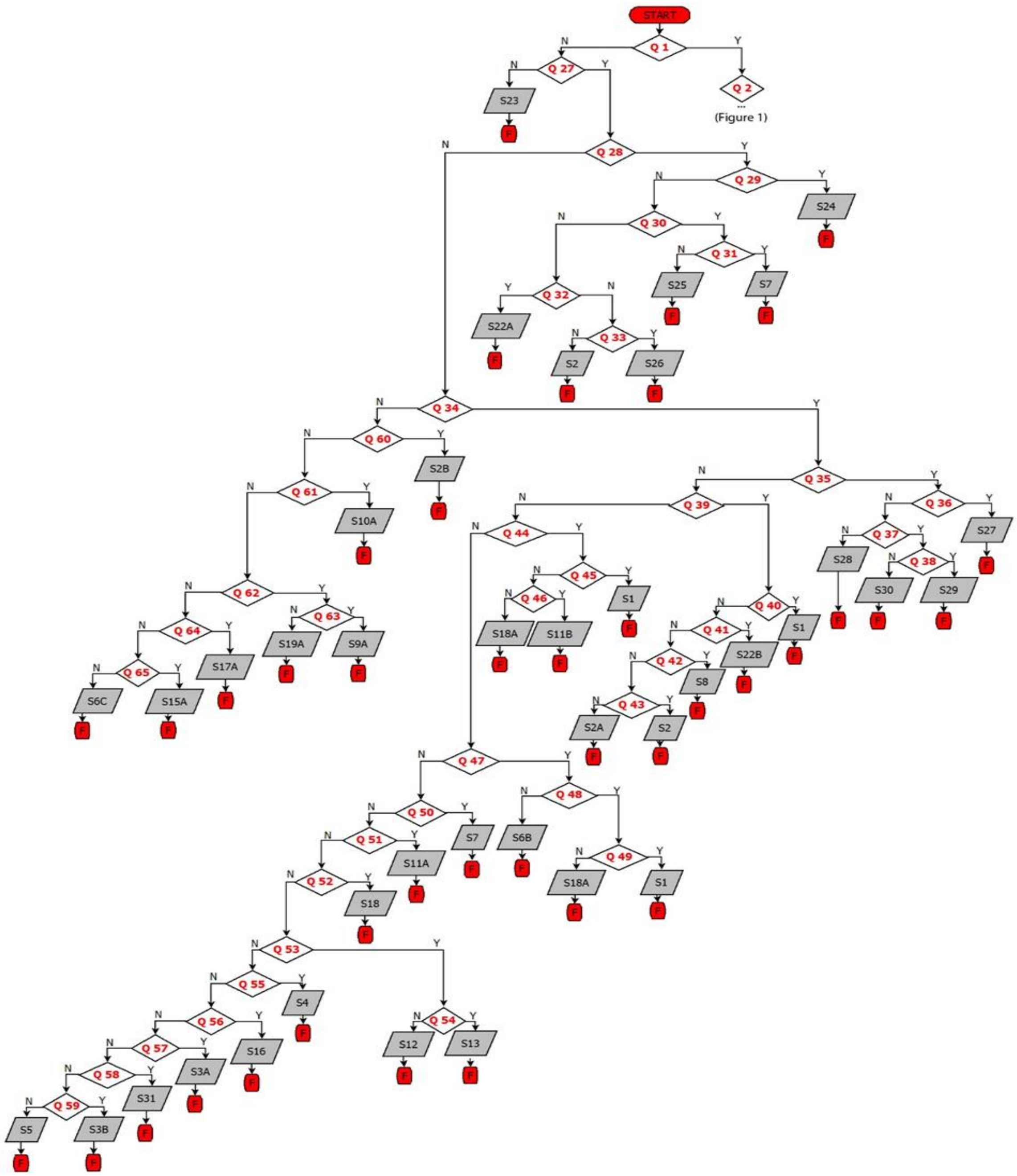

Figure 8. Diagram of the computer program between Q27 and Q65 (for an explanation of abbreviations see below)

Q: Question (for the contents of the questions are adapted from Harold Oldroyd, 1958), S: Screen (reached order form), Y: Yes; N: No; S1: Lepidoptera; S2: Hemiptera; S2A: Hemiptera; Homoptera; S2B: Hemiptera and larvae of some Neuroptera; S3A: Dictyoptera; Blattodea; S3B: Dictyoptera; Mantodea; S4: Orthoptera; S5: Phasmida; S6: Coleoptera; S6A: Coleoptera; Staphylinidae; S6B: Neuroptera or Coleoptera; S6C:

Larvae of Beetles Coleoptera; S7: Dermaptera; S8: Thysanoptera; S9: Ephemeroptera; S9A: Ephemeroptera - nymphs of Mayflies; S10: Trichoptera; S10A: Trichoptera - Larvae of Caddisflies; S11: Hymenoptera; S11A: Hymenoptera - Ants and wingless Wasps; S11B: Hymenoptera - Symphyta; S12: Zoraptera; S13: Psocoptera; S14: Embioptera; S15: Plecoptera; S15A: Plecoptera - Larvae of Stoneflies; S16: Isoptera; S17: Odonata; S17A: Odonata - Nymphs of Dragonflies; S18: Mecoptera; S18A: Mecoptera - Larvae of some Mecoptera; S19: Megaloptera; S19A: Megaloptera; Sialioidea; S20: Neuroptera; S21: Strepsiptera; S22: Diptera (Also males of Homoptera, family Coccidae, but these are very rare; S22A: Diptera - Louseflies and Batflies; S22B: Diptera - Wingless True flies; S23: Larvae and Pupae of Endopterygota; S24: Siphonaptera; S25: Mallophaga; S26: Anoplura; S27: Collembola; S28: Protura; S29: Thysanura; S30: Diplura; S31: Grylloblattodae; F: Finish

The insect classification is a section of ecology lesson in Suleyman Demirel University, Atabey Vocational School, however, this mentioned section is given as a lesson to the BSc, MSc, or Ph.D. students at most of the university in Turkey. The objective of this lesson is to teach both identify the general body parts of an insect and the classification system of insects to the students. Also, they are taught insect classification into orders, sometimes more families, genus even species level. At the end of the course; successful students can classify any given insects by using “a scientific insect classification key”. Many materials such as insects, insect pins, paper pins, clothespins, cotton balls, stencils, markers, napkins, scissors, glue bottles, masking tapes, insect drawers, styrofoam, insect classification key, 150 insect pictures (include all insect order level), etc. are needed for the lesson of insect classification. In the first eight weeks of the lesson the lecturer giving some information about the importance of insects, insect morphology; body parts using pictures mostly grasshopper, caput (head), thorax, abdomen, legs, and wings structure, etc. The students are wanted to prepare themselves to identify and familiarize himself/themselves with the distinct insect body parts. Last two weeks of the lesson each student is provided one insect photo as randomly given for identification insect order level using scientific insect classification key.

3. Results

In this part, the independent t-test results of the students who took the course and those who didn’t were analyzed. When the average values were analyzed, the less average means rank indicates more success based on the student evaluations because 1 stand for total agreement, 2 stands for agreement, 3 stands for undecided, 4 represents disagreement, 5 represents total disagreement.

3.1. Independent t-test results in the students who took the course in the 2010-2020 education period

When the test results of the students who took the course in the 2010-2011 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result, in the randomly distributed insect photos belong to by using the computer program where N= 70.

Table 1. Independent t-test results for the ones who use a computer program and who don't in the 2010-2011 education period in the students who took the course

Independent Samples Test									
	Levene's Test for Equality of Variances		t-test for Equality of Means						
	F	Sig.	T	Df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
								Lower	Upper
Equal variances assumed	24,042	,000	9,179	140	,000	2,07042	,22557	1,62447	2,51638
Equal variances not assumed			9,179	125,656	,000	2,07042	,22557	1,62402	2,51682

When the average values for the students who used a computer program and the ones who use the classical approach in the 2010-2011 education period, it can be seen that the ones who use classical approach have a higher average (3,59) indicating that they were less successful than the students who use the computer program in the ones who took the course (1,52).

When the test results of the students who took the course in the 2011-2012 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos belong to by using the computer program where N= 20.

Table 2. Independent t-test results for the ones who use a computer program and who doesn't in the 2011-2012 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	10,511	,002	4,578	38	,000	1,95000	,42597	1,08768	2,81232
	Equal variances not assumed			4,578	31,764	,000	1,95000	,42597	1,08208	2,81792

When the average values for the students who used a computer program and the ones who use a classical approach in the 2011-2012 education period, it can be seen that the ones who use classical approach have a higher average (3,75) indicating that they were less successful than the students who use a computer program (1,80).

When the test results of the students who took the course in the 2012-2013 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 71.

Table 3. Independent t-test results for the ones who use a computer program and who doesn't in the 2012-2013 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	76,560	,000	11,856	140	,000	2,46479	,20790	2,05376	2,87582
	Equal variances not assumed			11,856	97,252	,000	2,46479	,20790	2,05218	2,87740

When the average values for the students who used a computer program and the ones who use the classical approach in the 2012-2013 education period, it can be seen that the ones who use the classical approach have a higher average (3,81) indicating that they were less successful than the students who use a computer program (1,35).

When the test results of the students who took a course in the 2013-2014 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 31.

Table 4. Independent t-test results for the ones who use a computer program and who doesn't in the 2013-2014 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	15,782	,000	6,544	60	,000	2,12903	,32536	1,47821	2,77986
	Equal variances not assumed			6,544	48,826	,000	2,12903	,32536	1,47513	2,78294

When the average values for the students who used a computer program and the ones who use a classical approach in the 2013-2014 education period, it can be seen that the ones who use the classical approach have a higher average (3,67) indicating that they were less successful than the students who use a computer program (1,54).

When the test results of the students who took the course in the 2014-2015 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 78.

Table 5. Independent t-test results for the ones who use a computer program and who doesn't in the 2014-2015 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	68,214	,000	12,099	154	,000	2,28205	,18861	1,90945	2,65466
	Equal variances not assumed			12,099	107,601	,000	2,28205	,18861	1,90817	2,65593

When the average values for the students who used a computer program and the ones who use the classical approach in the 2014-2015 education period, it can be seen that the ones who use the classical approach have a higher average (3,67) indicating that they were less successful than the students who use a computer program (1,39).

When the test results of the students who took the course in the 2015-2016 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 70.

Table 6. Independent t-test results for the ones who use a computer program and who doesn't in the 2015-2016 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	34,304	,000	10,214	138	,000	2,24286	,21958	1,80869	2,67703
	Equal variances not assumed			10,214	115,833	,000	2,24286	,21958	1,80795	2,67776

When the average values for the students who used a computer program and the ones who use the classical approach in the 2015-2016 education period, it can be seen that the ones who use the classical approach have a higher average (3,74) indicating that they were less successful than the students who use a computer program (1,50).

When the test results of the students who took the course in the 2016-2017 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 70.

Table 7. Independent t-test results for the ones who use a computer program and who doesn't in the 2016-2017 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	65,931	,000	10,218	146	,000	2,18919	,21424	1,76578	2,61260
	Equal variances not assumed			10,218	111,098	,000	2,18919	,21424	1,76466	2,61372

When the average values for the students who used a computer program and the ones who use the classical approach in the 2016-2017 education period, it can be seen that the ones who use the classical approach have a higher average (3,70) indicating that they were less successful than the students who use a computer program (1,51).

When the test results of the students who took the course in the 2017-2018 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 64.

Table 8. Independent t-test results for the ones who use a computer program and who doesn't in the 2017-2018 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	61,010	,000	9,670	110	,000	2,19643	,22714	1,74628	2,64657
	Equal variances not assumed			9,670	76,927	,000	2,19643	,22714	1,74412	2,64874

When the average values for the students who used a computer program and the ones who didn't in the 2017-2018 education period, it can be seen that the ones who use classical approach have a higher average (3,58) indicating that they were less successful than the students who use a computer program (1,39).

When the test results of the students who took courses in the 2018-2019 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 64.

Table 9. Independent t-test results for the ones who use a computer program and who doesn't in the 2018-2019 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	45,203	,000	9,880	126	,000	2,21875	,22457	1,77433	2,66317
	Equal variances not assumed			9,880	96,923	,000	2,21875	,22457	1,77303	2,66447

When the average values for the students who used a computer program and the ones who use the classical approach in the 2018-2019 education period, it can be seen that the ones who use classical approach have a higher average (1,58) indicating that they were less successful than the students who use a computer program (0,85).

When the test results of the students who took the course in the 2019-2020 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 76.

Table 10. Independent t-test results for the ones who use a computer program and who doesn't in the 2019-2020 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	65,531	,000	10,427	150	,000	2,14474	,20568	1,73832	2,55115
	Equal variances not assumed			10,427	112,362	,000	2,14474	,20568	1,73721	2,55226

When the average values for the students who used a computer program and the ones who use a classical approach in the 2019-2020 education period, it can be seen that the ones who use the classical approach higher average (3,59) indicating that they were less successful than the students who use a computer program (1,44).

To sum up, when the test results of the students who took courses in the 2010-2020 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program. This implies the fact the computer program is very effective for the students who used the computer program.

3.2. Independent t-test results from the students who didn't take a course in the 2010-2019 education period

When the test results of the students who didn't take the course in the 2010-2011 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 20.

Table 11. Independent t-test results for the ones who use a computer program and who doesn't in the 2010-2011 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	2,643	,112	3,100	38	,004	1,40000	,45161	,48577	2,31423
	Equal variances not assumed			3,100	35,716	,004	1,40000	,45161	,48385	2,31615

When the average values for the students who used a computer program and the ones who use the classical approach in the 2010-2011 education period, it can be seen that the ones who use the classical approach higher average (1,59) indicating that they were less successful than the students who use a computer program (1,23).

When the test results of the students who didn't take the course in the 2011-2012 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 38.

Table 12. Independent t-test results for the ones who use a computer program and who don't in the 2011-2012 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	5,744	,019	4,846	74	,000	1,52632	,31496	,89875	2,15388
	Equal variances not assumed			4,846	68,512	,000	1,52632	,31496	,89791	2,15472

When the average values for the students who used a computer program and the ones who use the classical approach in the 2011-2012 education period, it can be seen that the ones who use the classical approach higher average (3,52) indicating that they were less successful than the students who use a computer program (2,00).

When the test results of the students who didn't take the course in the 2012-2013 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 60.

Table 13. Independent t-test results for the ones who use a computer program and who doesn't in the 2012-2013 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	,841	,361	7,417	118	,000	1,73333	,23370	1,27055	2,19612
	Equal variances not assumed			7,417	115,819	,000	1,73333	,23370	1,27046	2,19621

When the average values for the students who used a computer program and the ones who use the classical approach in the 2012-2013 education period, it can be seen that the ones who use the classical approach higher average (3,63) indicating that they were less successful than the students who use a computer program (1,90).

When the test results of the students who didn't take the course in the 2013-2014 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 62.

Table 14. Independent t-test results for the ones who used a computer program and who don't in the 2013-2014 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	9,875	,002	6,860	122	,000	1,54839	,22571	1,10157	1,99521
	Equal variances not assumed			6,860	111,215	,000	1,54839	,22571	1,10113	1,99564

When the average values for the students who used a computer program and the ones who use the classical approach in the 2013-2014 education period, it can be seen that the ones who use the classical approach higher average (3,27) indicating that they were less successful than the students who use a computer program (1,72).

When the test results of the students who didn't take the course in the 2014-2015 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 40.

Table 15. Independent t-test results for the ones who used a computer program and who doesn't in the 2014-2015 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	7,204	,009	4,799	78	,000	1,40000	,29171	,81925	1,98075
	Equal variances not assumed			4,799	69,377	,000	1,40000	,29171	,81811	1,98189

When the average values for the students who used a computer program and the ones who use the classical approach in the 2014-2015 education period, it can be seen that the ones who use the classical approach higher average (3,17) indicating that they were less successful than the students who use a computer program (1,77).

When the test results of the students who didn't take the course in the 2015-2016 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 60.

Table 16. Independent t-test results for the ones who used a computer program and who don't in the 2015-2016 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	10,528	,002	5,840	118	,000	1,45000	,24830	,95830	1,94170
	Equal variances not assumed			5,840	108,937	,000	1,45000	,24830	,95788	1,94212

When the average values for the students who used a computer program and the ones who use the classical approach in the 2015-2016 education period, it can be seen that the ones who use the classical approach higher average (3,30) indicating that they were less successful than the students who use a computer program (1,85).

When the test results of the students who didn't take the course in the 2016-2017 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 40.

Table 17. Independent t-test results for the ones who used a computer program and who don't in the 2016-2017 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	1,202	,276	1,921	78	,058	,62500	,32539	-,02281	1,27281
	Equal variances not assumed			1,921	77,308	,058	,62500	,32539	-,02290	1,27290

When the average values for the students who used a computer program and the ones who use the classical approach in the 2016-2017 education period, it can be seen that the ones who use the classical approach higher average (2,92) indicating that they were less successful than the students who use a computer program (2,30).

When the test results of the students who didn't take the course in the 2017-2018 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 42.

Table 18. Independent t-test results for the ones who used a computer program and those who don't in the 2017-2018 education period.

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	2,967	,089	4,437	82	,000	1,26190	,28438	,69618	1,82763
	Equal variances not assumed			4,437	79,301	,000	1,26190	,28438	,69589	1,82792

When the average values for the students who used a computer program and the ones who use the classical approach in the 2017-2018 education period, it can be seen that the ones who use the classical approach higher average (3,19) indicating that they were less successful than the students who use a computer program (1,92).

When the test results of the students who didn't take the course in the 2018-2019 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 58.

Table 19. Independent t-test results for the ones who used computer program and who don't in 2018-2019 education period.

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	9,329	,003	5,734	114	,000	1,32759	,23151	,86897	1,78620
	Equal variances not assumed			5,734	102,291	,000	1,32759	,23151	,86841	1,78677

When the average values for the students who used a computer program and the ones who use the classical approach in the 2018-2019 education period, it can be seen that the ones who use the classical approach higher average (3,08) indicating that they were less successful than the students who use a computer program (1,75).

When the test results of the students who didn't take the course in the 2019-2020 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program where N= 50.

Table 20. Independent t-test results for the ones who used a computer program and who doesn't in the 2019-2020 education period

Independent Samples Test										
		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
VAR00002	Equal variances assumed	,387	,535	3,772	98	,000	,98000	,25981	,46441	1,49559
	Equal variances not assumed			3,772	96,929	,000	,98000	,25981	,46434	1,49566

When the average values for the students who used a computer program and the ones who use the classical approach in the 2019-2020 education period, it can be seen that the ones who use the classical approach higher average (3,18) indicating that they were a little bit successful than the students who use a computer program (3,20).

To sum up, when the test results of the students who didn't take the course in the 2010-2019 education period were investigated, it was found that there was a significant difference on the behalf of the students who reached the desired result in the randomly distributed insect photos by using the computer program. This implies the fact the computer program is very effective for the students who used the computer program even though they didn't take the course.

4. Discussion

As seen from figure 9, the longitudinal data regarding both experimental and control groups show that most students using computer programs are more successfully reached the desired result to classify the randomly distributed insect photos. More surprisingly, as for the students who didn't take the course, similar results were achieved as well.

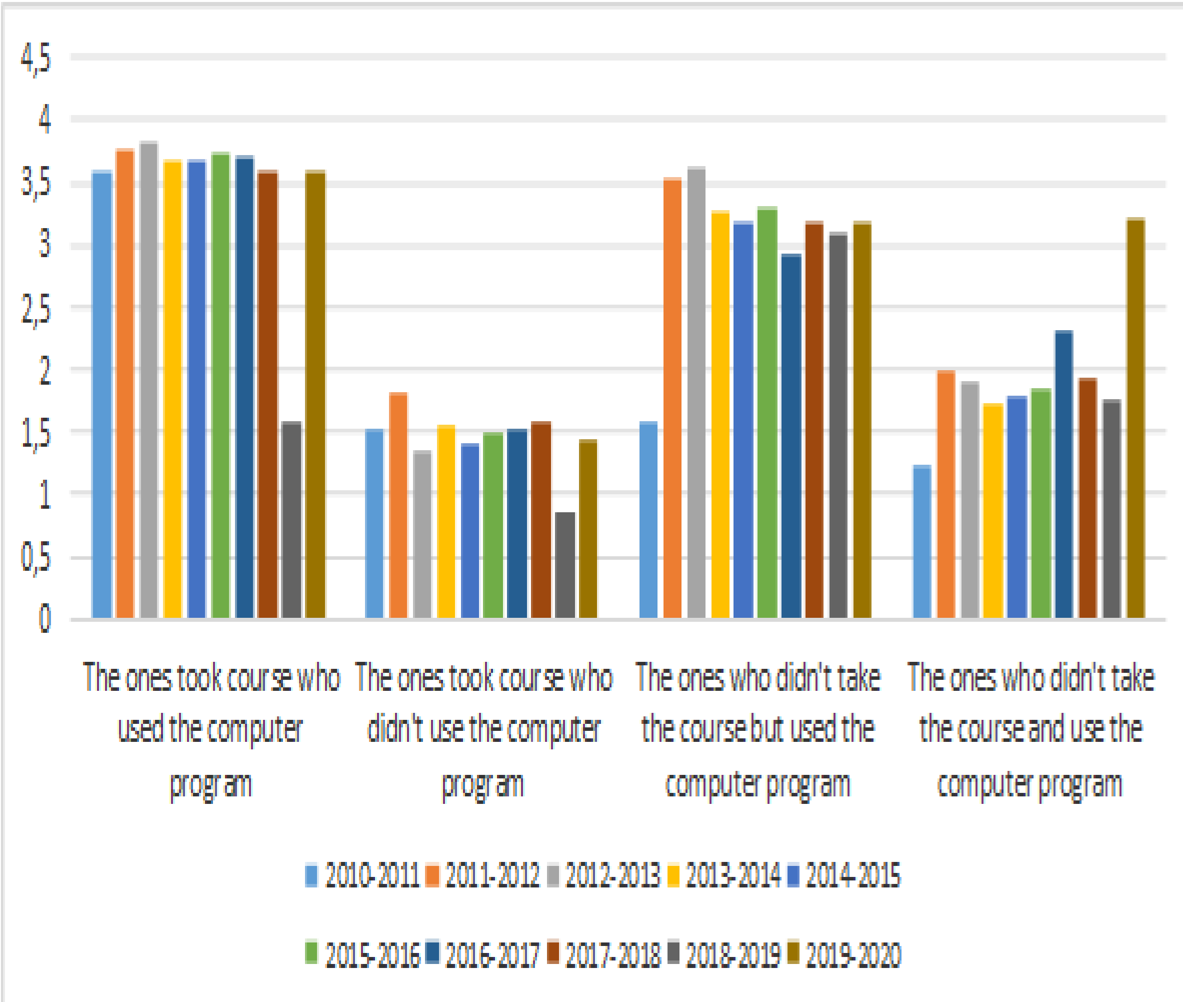

Figure 9. Comparison of the achievement results of the students who used the computer program and who didn't use the computer program

The roots of instructions based on computer technologies can be traced back to the Programmed Instruction Educational Model implemented by B. F. Skinner (Taşpınar, 2005:101; Küçükahmet, 2008:114) Programmed instruction is a technique based on the reinforcement principles of the famous psychologist Skinner. It should be noted that programmed instruction has developed in response to traditional methods. Programmatic instruction enables the student to participate actively in the learning process, to progress according to the individual learning speed, and to control the learning outcome instantly. Programmatic instruction includes the analysis of behavior, organizing the content according to the principle of small steps, evaluating it at short intervals, and correcting it instantly by giving feedback to the student about the subject of learning (Karaağaçlı, 2005). Therefore, "Instructional Machines", which have an important place in the shaping of "Programmed Instruction", are the first examples of the educational technology used today. Pressey is known as the one who invented the teaching instructional machines in the 1920s. The instructional machines were developed as small question tools used with tests (Koşar, 200; Rıza, 2003).

Today computers and computer programs are used in many areas of education ranging from simulations to language learning. Riel (2000) stated that computer technology may improve the academic success of kids under the right conditions (Garraway-Lashley, 2014). So computer technology can promote the skills of students and transform their working, thinking, and learning (Berson, 2003). Computer-aided education is a vital factor for enhancing the quality and efficiency of education. The conventional method of education that uses a book or paperwork may easily make the learner bored and difficult to grasp what they learned. The information must be extracted from everywhere in the book, and it may take a lot of time. Differ from computer-aided education which is much easier to amend and update the material. Computer-aided education may also minimize the cost of publication and dissemination (Cingi, 2013; Sabariman, 2008). The program developed there also shows the effectiveness of computer-aided education for learning a biological taxonomy. In other words, the academic performance of students who were exposed to computer technology was significantly different from that of those who were exposed to the conventional style of teaching.

5. Conclusions

The learning activity takes place in the long-term and short-term memory of the students. The first short time of learning is stored in their memory. In the later stages, if the students perform the necessary practices in sufficient numbers, the information they have learned will remain in memory for a long time. One of the promising typical studies on this subject is computer-assisted instruction (Isman, 2001; Alcapinar, 2007).

The first indication of this study is that the computer program developed for the identification of insects is very effective for the students who took the course comparing the one using the classical method for the identification of insects. The second indication of the study implies that the computer program is very effective for the students who used the computer program even though they didn't take the course.

The second indication of this study is that the computer program developed for the identification of insects is very effective to improve the computational thinking skills of the students in terms of abstraction, automation, data analysis, decomposition, pattern generalization, pattern recognition skills. Finally, it can be concluded that computer program used for the identification of insects is very effective irrespective of whether the instruction is taken or not.

It provides many opportunities such as determining the speed of learning, interactive learning, use of instructional software, and saving time. Approaches to computer software in educational environments have a significant impact on the effective use of this device. Thanks to this program, the student can repeat the topics he/she does not understand as much as he wants, since he/she can follow his / her development process and organize the progress of the subject at any time (Mercan et al. 2009).

Another important benefit of computer learning is that the level is determined by the student, unlike traditional learning models. As an example of the benefit of Computer Assisted Education, Apple's project (Apple Classrooms of Tomorrow-ACOT) describes how teachers 'and students' continuous and systematic computer use affects the teaching-learning process. In this project, in seven classes selected from primary and secondary schools in the USA, each student and teacher were given two computers, one at school and one at home. The following results were obtained in the researches carried out within the scope of the project. At the end of the four-year education in the project, the achievement levels of the students within the scope of the project were very high compared to the success of the 216 students who passed through traditional education (Mercan et al. 2009). This program can be further developed for the identification of different species and kinds. The effectiveness of this program can be tested through different samples and research designs. The effectiveness of the program can be compared with other computer program or teaching methods as well.

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