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The Effect of the Universal Design Model in Learning on the Academic Success of Eighth Grade Students: The Subject of Heredity

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Abstract

The aim of this study is to determine the effect of teaching the heredity subject with the Universal Design for Learning (UDL) on students' academic achievement towards science lesson. In addition, during the implementation of this teaching model, it was aimed to determine the effects of computer/tablet, internet availability at home and presence of helpers at home variables on the results. The study was conducted with 73 8th grade students of a public school in Kars in the 2021- 2022 academic year. In the study, two of the four classes were determined as the experimental group and two as the control group. While the lessons in the experimental group were taught according to the plans prepared within the framework of UDL, the control group was taught within the framework of the activities recommended in the curriculum. The data were collected with the 8th Grade Heredity Subject Achievement Test and the Personal Information Form prepared to determine the demographic characteristics of the students. Multi-Factor Analysis of Variance (MANOVA) was used in the analysis of the quantitative data obtained in the study. When the pre-test and post-test scores of the students in the experimental and control groups were compared, it was seen that there was a significant difference in favor of the experimental group. As a result, it was determined that the course taught according to UDL increased the academic achievement of the students the science course, regardless of all these variables. The implementation of the UDL model by teachers in the design of inclusive practices for effective and efficient science education in rural areas is among the recommendations of this research.

Keywords: Universal design for learning , science education, heredity

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Introduction

The effects of developments in the field of heredity, which is one of the science subjects, on individuals and society have been increasing in recent years (Bowling et al., 2008). In this respect, it is important for individuals to understand the subject of heredity and to be well literate. Individuals need to understand the science of heredity and have knowledge of biological terms and concepts in order to increase their level of genetic literacy (Bowling et al., 2008; Pardo et al., 2002). Therefore, the curriculum has been updated in our country (MEB, 2018). When the eight grade heredity acquisitions are examined, it is aimed to increase the awareness of individuals and to improve their knowledge and skills by including topics such as recognition of the individual's family tree, transfer of character, hereditary diseases and treatment methods, genetic engineering and biotechnology applications (MEB, 2018). But Heredity, which is one of the subjects of the science course, is one of the subjects whose terms are unfamiliar to students, contain abstract concepts, have difficulty in establishing cause-effect relationships and constructing knowledge, and are not very suitable for experimentation (Bahar, Johnstone, & Sutcliffe, 1999). The fact that the subject of heredity contains abstract and complex concepts that students do not encounter in daily life makes it difficult to understand the subject and leads to learning the information by rote. Since knowledge cannot be assimilated and interpreted, it cannot be constructed by the student (Eliason & Jenkins, 2008; Harms, 2002). Many different materials and teaching methods have been used in order to teach the subject of heredity until today. Yıldız et al. (2016) examine the effects of Jigsaw integrated problem-based teaching method and program-based teaching practice. Balcı (2015) applies scientific argumentation-based learning techniques. Özsevgeç and Kocadağ (2013) examine the effects of the scenario-based learning approach. Aydın (2011) examines the effects of activities suitable for the constructivist approach on students by using conceptual change texts, concept maps, mind maps, concept cartoons, analogies, and models. Şahin and Hacıoğlu (2010) apply the case study method supported by scientific discussion. However, it is revealed that the success in teaching heredity is not at the desired level as a result of these studies (Bowling et al., 2008; Gürbüztürk et al., 2017; Köse, 2019; Saka and Cerrah, 2014) (Gürbüztürk et al., 2017). It is thought that the failure in teaching the subject of heredity is due to the uniformity of the teaching process without taking into account the individual differences of the students (Musgrove, 2002). It is necessary to determine the factors (individual differences) that will affect their learning in order for students to achieve the desired level of learning in the lessons (Okçu et al., 2016). However, since today's science courses are not processed by taking into account student differences, students carry out different teaching activities (support from the helper at home, internet and computer activities) in order to realize permanent learning (Şen and Gülcan, 2012).

Students try to realize the learning that they cannot achieve at the desired level in the classroom environment by making use of the helpers, the internet and the computer in the home environment (Englund et al., 2004). These activities enable students to develop their newly learned knowledge and skills, facilitate and reinforce learning, provide active learning, and increase the permanence of learning (Güneş, 2014). The factors in the home environment are as important as the school in order for learning to take place at the desired level (Robert et al., 2000; Votruba-Drzal, 2003). According to Vygotsky, the people around them have an important place in the knowledge and thoughts that children learn and in gaining various skills (Çakıcı, 2010; Robert et al., 2000). For example, the factors such as supporting and guiding students at home are known to significantly affect learning in terms of providing academic support to the child (Alfaro & Taylor, 2015; Eccles, 2007; Kim, 2015). Marchant et al. (2001) state that the helpers at home play an important role in order to increase student achievement. In addition, the ability of learners to access information when and where they need it is one of the factors that facilitate learning (Gogoi, 2014). Technology and its products are frequently utilized in the field of education at this point as in many different areas (Dickinson & Bass, 2020; Martinovic & Zhang, 2012). Today, many studies show that there are a lot of benefits of using information technology in education with tools such as the internet and computers/tablets (Anderson & Barnett, 2011; Roblyer & Edwards, 2005; Stubbé et al., 2016). For instance, Rugayah et al. (2004) state that the use of technology and computers in education increases the self-confidence of individuals and positively affects their competence. Milner et al. (2010) reveal in their study that the presence of internet technology positively affects academic achievement in science education. However, not every student will have the opportunity to use the Internet, a computer, or someone to

get help at home. In this case, students who cannot reach the desired level of learning in the classroom may not be able to improve their learning status outside of school. Thus, it has come to the fore that the education given in classroom environments should take into account the differences of the students and enable them to realize permanent learning.

It is known that each student who comes to the educational environment can differ in many aspects such as his/her development, readiness level, prior knowledge level, interest, preference, needs, learning method, socio-cultural and socio-economic status (Al-Azawei et al., 2016; Tomlinson, 2009). This diversity in classroom environments necessitates variety in the education system for students whose educational needs are differentiated (Gregory & Chapman, 2002; Turville et al., 2010). The United Nations Educational, Scientific and Cultural Organization (UNESCO) also emphasizes the importance of all students, especially those who are excluded or marginalized for different reasons, to access quality education without any discrimination within or outside the school system. In this context, it is stated that there is a need for educational policies that can respond to student diversity and a deep transformation in education systems (UNESCO, 2009). Therefore, education researchers have put forward the Universal Design Model in Learning (UDL) that will enable students to realize more permanent and meaningful learning by taking into account their differences (Çakır and Sezgin-Mumcu, 2019).

UDL is defined as a set of principles that enable all students to learn better with the philosophy of designing and delivering flexible learning and teaching approaches by addressing student diversity in classrooms (Capp, 2017). UDL tries to address the limiting factors in the learning environment rather than the limiting effect of the differences among learners. In the UDL, accessible applications and learning environments are targeted where all students will be involved in the learning process (Al-Azawei et al., 2016). Thus, education becomes more flexible as it enables each individual with different characteristics to learn the same content in the most appropriate way (Hall et al., 2012). Teaching will be accessible to a wider student population when the courses prepared according to UDL are purposefully designed to include more than one tool for accessing, processing and internalizing information (Gravel and Rose, 2009). This teaching model provides an all-student framework by helping teachers create a flexible curriculum that includes teaching objectives, methods, materials, and assessments in standardized environments using innovative technologies (Meo, 2008). UDL increases the motivation of students by making the learning process more interesting. Thus, students try to be more active and participatory in the lesson (King-Sears, 2009). In addition, students are better able to make sense of abstract concepts in the classrooms where the UDL is applied (Miller and Lang, 2016). Many studies on the UDL model show that it has positive effects on the cognitive and socio-emotional development of many children with/without disabilities in general (Cole et al., 2004; Ruijs & Peetsma, 2009; Krämer et al., 2021). Lee et al. (2015) examine the impact of UDL on students' academic achievement and motivation in science classes. As a result of his study, it is found that the academic success of the students and their motivation for science learning increase positively in the courses where the UDL is applied. Wusqo and Jatiningsih (2022) examine the effect of Science digital scrapbook based on UDL on students' academic achievement in science course. As a result of the study, it is determined that there is a positive increase in the academic success of the students. In their study, Tavares et al. (2021) aim to reveal how the mobile application they prepared according to the principles of the UDL would support students' own learning. It is determined that the mobile application prepared as a result of the study provides the expected competence in order to support the students' own learning. Hitchcock et al. (2016) examine the effects of activities prepared by taking into account the principles of UDL on the development of students' descriptive writing skills in science lesson in their study. As a result of the study, it is determined that the explanatory writing skills of the students develops positively.

Considering all these factors, it is thought that teaching the 8th grade heredity subject with lesson plans prepared according to the principles of the UDL will increase the academic success of each student and realize meaningful learning by neutralizing student differences and some factors in the home environment (helper at home, internet and computer presence). Thus, it is predicted that students will not have to need an individual, internet and computer to help them in the home environment in order to realize meaningful and permanent learning. In this context, the problem sentence of the research is

stated as follows: "Do the variables of computer/tablet, internet and the presence of someone who helps with the lesson at home in the teaching of the subject of heredity in the 8th grade science course with the UDL model have an effect on the academic success of the students the science course?" The following sub-problems are accordingly searched.

1. Does the variable of the presence of a computer/tablet at home in teaching the subject of heredity with the UDL model have an effect on the academic success of the students the science course?

2. Does the variable of internet presence at home in teaching the subject of heredity with the UDL model have an effect on the academic success of the students science courses?

3. Does the variable of the presence of someone who helps with the lesson at home in teaching the subject of heredity with the UDL model have an effect on the academic success of the students the science course?

Purpose of the Research

The aim of this study is to determine the effect of teaching heredity that is the 8th grade science course subject by using UDL principles on students' academic achievement science course. In addition, it is aimed to determine the effects of the variables of computer, internet and someone who helps with the lesson at home on the results during the implementation of this teaching model.

Hypotheses

1. When the achievement test pre-test scores of the experimental group and the control group are examined, it is seen that there is a significant difference between the post-test scores in favor of the experimental group.

2. The variable of having a computer at home has no effect on students' academic success in teaching the subject of heredity with the UDL model.

3. In teaching the subject of heredity with the UDL model, the variable of internet presence at home has no effect on the academic success of the students.

4. In teaching the subject of heredity with the UDL model, the variable of having a learning helper at home has no effect on the academic success of the students.

Method

In this section, there is information about the research model, working group, development processes of data collection tools, experimental process, data collection and analysis.

Research Model

This study is carried out according to the pretest-posttest model from quasi-experimental designs, which is one of the quantitative research methods. The comparisons are made with pre- and post-experimental measurements in both groups. The group in which the course is taught in accordance with the plan prepared according to the principles of UDL is called the "Experimental Group", and the group in which the course is taught as suggested in the curriculum is called the "Control Group" in the research. The experimental design used in the study is given in Table 1.

Table 1.
Experimental Pattern of Research

Group	Pre-Test	Application	Post-Test
Experimental Group	1.Achievement Test	The course is taught according to the principles of UDL.	1. Achievement Test
Control Group	1. Achievement Test	The course is taught with the activities as suggested in the curriculum.	1. Achievement Test

Academic achievement test scale is applied as pre-test to the students in the experimental and control groups at the beginning of the application in the study carried out by the researcher. The subject of “Heredity” of the “DNA and Genetic Code” unit of the 8th grade science course of secondary school has been applied to the experimental groups by the researcher teacher and to the control groups by

their own course teacher for 3 weeks (12 course hours). The research teacher works as a science teacher in a secondary school affiliated to the Ministry of National Education. The study has been carried out on students who conduct science courses in the school where the research teacher works. Since the researcher teacher is the science teacher of the students, it is estimated that the students will exhibit their real behaviors in the lessons conducted within the scope of the study. After the achievement test has been re-applied to both workgroups as a post-test at the end of the application, they have been evaluated.

Study Group

The research has been conducted in a secondary school located in the center of Kars province, which differs significantly in socioeconomic and sociocultural aspects. The convenience sampling technique, which is one of the purposeful sampling methods, is applied in the study conducted with 73 (N: 36 females, N: 37 males) 8th grade (8A, 8B, 8C and 8D) students in the 2021-2022 academic year. The classes 8A and 8B have been chosen as the control group, and classes 8C and 8D have been selected as the experimental group for the application part of the research. The researcher teacher conducted the lessons in the experimental group, and their own teachers conducted the lessons in the control group. In this case, it is thought that the sample will reflect the general in accordance with the study problem. The demographic characteristics of the students have been investigated in order to obtain information about the students before the study. The demographic characteristics of the groups included in the study are given in Table 2.

Table 2
The Results of the Demographic Characteristics of the Students Included in the Study

	The Demographic Characteristics of the Students		
	Total N:73	Control N:37	Experimental N:36
The presence of computer/tablet at home N (%)	51 (% 69.9)	26 (70.3 %)	25 (69.4 %)
The Presence of internet connection at home N (%)	63 (% 86.3)	31 (83.8 %)	32 (88.9 %)
The presence of someone who helps with the lesson at home N (%)	37 (% 50.7)	16 (43.2 %)	21 (58.3 %)

When the ratios of the investigated variables in the experimental and control groups are examined in Table 2, it is seen that there is no significant difference between the two groups.

Data Collection Tools

The information about the academic achievement test and information form used in the data collection process is given in this section.

Academic Achievement Test

The academic achievement test consisting of 12 multiple-choice questions in total prepared by Rencüzoğulları (2022) is used in the study. Coronbach's Alpha coefficient calculated to check the reliability of the achievement test was found to be 0.825. In addition, the average difficulty of the prepared multiple-choice test was calculated as 0.64. It is aimed to compare the differences in cognitive level between the groups by examining the knowledge levels of the eighth grade students participating in the study about the subject of Heredity in the form of pre-test and post-test with the help of this test.

Information Form

A form is prepared to collect information in order to compare the variables of the participants' status of having computers, tablets, etc. at home, having internet at home and presence of person(s) to help their lessons at home. The researcher has first examined the literature and has created the draft information form for the problem situations of the study during the preparation process of the form. Then, three academicians who are experts in the field have examined the draft information form and the necessary feedbacks are given to the researcher. The final version of the information form has been created by the researcher by making the feedbacks given by the academicians.

Data Collection Process

The information form prepared within the scope of the study is applied to both the experimental and control groups at the beginning of the data collection process. After the achievement test prepared within the scope of the achievements on Heredity have been applied to both the experimental and control groups in order to determine the readiness levels of the students, and the pre-test data of the students have been obtained. After this stage, the experimental process has been carried out for the experimental and control groups for three weeks.

Experimental Group Experimental process

First, the characteristics of the learners, the difficulties in teaching the subject, the needs in the learning environment and the arrangements that can be made are tried to be determined. Three different lesson plans have been prepared within the framework of the UDL principles which are applied to the experimental group. During the preparation of the lesson plans, lesson plan examples in the literature and on the internet, studies and resources related to the subject in our country have been examined. Appropriate activities have been determined and lesson plans have been created to include the three principles and nine control points of UDL. The lesson plans prepared after this stage has been shown to three faculty members who are experts in their fields and their suitability has been examined. The lesson plans on the subject of heredity prepared within the framework of the principles of the UDL have been rearranged and the plans have been finalized in line with the expert feedback. After this stage, the materials of the activities that will be used in the courses where the subject of Heredity is covered, have been prepared and the students have been informed about the purpose of the course, the applications that will be made and the process. Finally, within the framework of the principles of the UDL and in line with the expert opinions, three different lesson plans prepared for the subject of heredity have been implemented by the research teacher, who is the current teacher of the relevant class, within the scope of the relevant course. The examples of teaching-learning activities in the lessons conducted in the experimental group are given below.

The concepts of heredity are presented to students in many ways. First of all, the achievements have been shown in such a way that the students can see them on the smart board. Afterwards, a short article emphasizing the diversity among family members has been read. Meanwhile, the teacher has showed the text and the corresponding image on the smart board. The videos have been showed from EBA and Morpa Campus education networks on the subject. The ideas of the students about the subject they have watched in the text, visual and video have been taken. The teacher has explained what they will learn, the importance of the subject and where they will encounter this subject in life, and where the subject is used. S/he has showed a visual with concepts and symbols related to the subject and has asked what the students know about these concepts and symbols, and has stated that the concepts they will learn will be symbolized with letters. However, s/he has not dilated upon at this stage. Afterwards, a short video describing the subject was shown on EBA and Morpa Campus education networks.

The teacher has used analogies to comprehend the subject. Five sections have been created in the classroom so that students can express what they have learned. It is stated to the students that they can do the activity in the section they want. The first four sections are examples below. The first group has been asked to express the subject concepts using mixtures of yellow and black food colorings in two separate bottles, and each student has been asked to fill in the template prepared by the teacher for the activity.

Section 1. Ink activity

Mixture	Composed color	Dominant color	Recessive color	Pure (Homozygous)	Crossbreed (Heterozygous)	Phenotype	Genotype
Yellow+Black							
Black+Black							
Yellow+Yellow							

Fill in the table by preparing the yellow and black mixtures prepared with inks as indicated. Compare your tables.

In the second group, a student has been asked to draw cards with different letters (A,a,B,b) from the bag. Each student in the group is told to fill out the template prepared by the teacher about the activity according to the cards drawn.

Section 2. Card activity

Fill in the blanks in the table using the cards you will draw from the bag. Compare your tables.

A: Curly hair	a: Straight hair
B: Tall	b: Short

Dominant gene	Recessive gene	Pure (Homozygous) progeny	Crossbreed (Heterozygous) progeny	Phenotype	Genotype

The third group has been told that they can do the matching activity prepared by the teacher in the wordwall gamification-based tool from the smart board.

Section 3. Interactive board

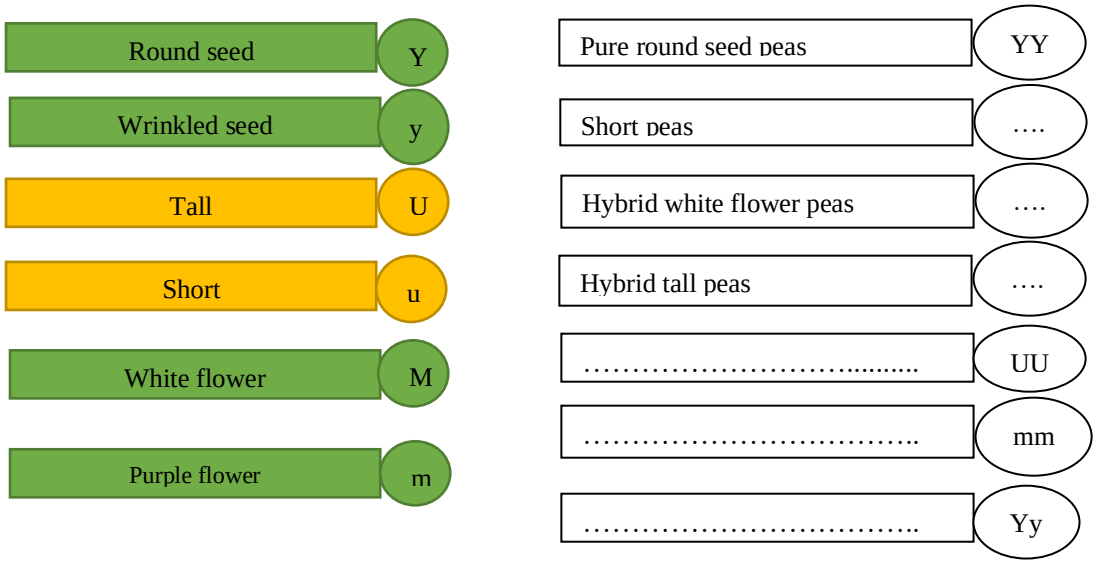
Do the activities on the interactive board (Wordwall, Morpakampus, EBA platforms have been used)

After the students have completed the sections they want to study in the specified time, the activities have been evaluated together, and the parts that the students have been stuck on are tried to be determined. While the activities have been carried out, the students have been directed to work together in the group, to compare their tables and to share their thoughts with each other. They are told that they can ask each other their own problem sentences. The options are offered where students can create their own analogies, work using web 2 tools or different computer programs, and express what they have learned by writing, drawing, creating a concept map. The studies in the section attended by the student who wants to work individually or who has speech disorder have been checked by the teacher and it is stated that the students can work in different ways they prefer. The teacher has reminded the students that s/he will help them if they need teacher support.

The teacher has asked the students to complete the work by showing the study on the screen, which include more than one concept and mixed examples.

Section 4. Gap-filling

Some dominant and recessive features in peas are given below with letters. Fill in the blanks. Compare and discuss your tables with each other.



Control Group Experimental process

In the control group, the experimental process was carried out by the current teacher of the relevant classes, within the framework of the activities suggested in the curriculum for 3 weeks, using the methods and techniques of lecture, question and answer, problem solving, test solving, and discussion.

After the experimental process in the two groups has been completed, the academic achievement test prepared for the subject of Heredity, which we have applied in the pre-test, have been re-applied to the experimental group and the control group, and the post-tests have been obtained.

Data Analysis

The data obtained at the end of the study are analyzed with SPSS 20 program. Before the analysis, kurtosis and skewness values are examined in order to understand whether the data show a normal distribution. When the literature is examined, Chou and Bentler (1995) state that the data exhibit a normal distribution when the kurtosis and skewness values are in the ranges of -2, +2 and -7, +7. Within the scope of the study, the kurtosis value for the academic achievement pre-test is 5.46, the skewness value is -1.85, the kurtosis value for the post-test is -0.29 and the skewness value is 0.27. In this context, it is understood that the academic success of the students participating in the study are normal or close to normal. In the analysis of the data, two-way multivariate analysis of variance (MANOVA) was used to examine whether there was a differentiation in the academic achievement levels of the students in the control and experimental group for the 8th grade heredity subject according to their status of having a computer, having the internet and being a helper at home. MANOVA allows to reveal which factor is more important by evaluating more than one dependent variable together. This analysis method can be summarized as creating a new dependent variable from the best linear combinations of the dependent variables in the study and comparing the groups with the analysis of variance for this new dependent variable (Alpar, 2003). Stevens (1996) stated that MANOVA should be preferred in cases where groups are compared over dependent variables that have the same structure and are correlated with each other, since it deals with these dependent variables simultaneously (simultaneously).

According to the constructivist approach, students' prior knowledge affects their new learning (Bodner, 1990). Based on this theoretical basis, the pretest scores and posttest scores obtained within the scope of the study were simultaneously included in the analysis. In the analyzes, it was examined whether the academic achievements of the students in the experimental and control groups on the subject of heredity, whether the pretest and post-test scores differed according to whether they had a computer, whether they had internet and whether there was a helper at home. Thus, the joint effect of two independent variables on two dependent variables was revealed. Since the joint effect of the independent variables on the pretest scores of the research groups was not significant, it was not necessary to use the pretest scores as a control variable.

Ethical Procedures

Before the study, the application of the relevant study, numbered E-45591 and dated 30.12.2021, was examined by the Scientific Research and Publication Ethics Committee of Kafkas University, and it was determined that there was no scientific ethical objection for the realization of the study and the necessary permission was given.

Results

In this section, the results obtained from the research and statistical analyzes are interpreted and presented in accordance with the order of the sub-problems.

Results Obtained from MANOVA Analysis of Academic Achievement Scores According to the Presence of a Computer / Tablet at Home

Two-way multivariate analysis of variance was performed to determine the joint effect of the research groups on academic achievement, pretest and posttest scores according to whether they had a computer at home or not, and the results of the analysis were presented in Table 3 and Table 4. The

descriptive statistics of the achievement scores of the students participating in the research according to the group and presence of computer variables are given in Table 3.

Table 3.
The Descriptive Statistics of Achievement Scores According to the Group and the Presence of Computer Variables

Variable	Group	The Presence of Computer	N	$\bar{X}$	SS
Achievement pretest	Experiment	There is no computer at home	11	14.81	3.28
		There is a computer at home	25	13.60	3.94
		Total	36	13.97	3.75
	Control	There is no computer at home	11	15.27	1.10
		There is a computer at home	26	15.69	1.66
		Total	37	15.56	1.51
Achievement posttest	Experiment	There is no computer at home	11	18.82	2.04
		There is a computer at home	25	19.64	2.32
		Total	36	19.39	2.24
	Control	There is no computer at home	11	16.45	1.57
		There is a computer at home	26	17.57	2.38
		Total	37	17.24	2.22

It is seen that the achievement pre-test scores of the students in the control group participating in the research are higher than the experimental group, while the achievement post-test scores are lower. In addition, it is understood that the achievement pre-test scores of the students in the control group who have a computer at home and who do not have a computer at home are higher than the students in the experimental group with and without a computer at home. However, the opposite is true for the achievement post-test scores. Two-way multivariate analysis of variance (two-way MANOVA) is used to determine whether the common effects of group and the presence of computer independent variables make a difference on success, and the results of analysis are given in Table 4.

Table 4.
Two-Way MANOVA Results of Achievement Points Based on the Presence of Group*Computer Variables

Effect	Wilks' Lambda	F	Hypothesis SD	Error SD	p	Partial η^2
Group	.73	12.68	2.00	68.00	.001	.272
The presence of Computer	.94	2.15	2.00	68.00	.125	.059
The presence of Group Computer	.98	.63	2.00	68.00	.537	.018

When the common effects of the presence of group*computer variables are examined in Table 4, it is found that the dependent variables do not differ (Wilks' Λ=.982; F(2;68)=0.628, p>.05, η2=.018). It will be seen that the common effect of the presence of group*computer is small (η2=.018). According to Cohen (1988), η2 = .01 is interpreted as a "small" effect, η2=.06 as a "moderate" effect, and η2=.14 and above as a "large" effect. Accordingly, the scores of the linear component of the achievement pre-test and post-test scores do not differ between the students in the experimental and control groups who have and do not have a computer at home.

Results Obtained from MANOVA Analysis of Academic Achievement Scores According to the Presence of the Internet at Home

Two-way multivariate analysis of variance was performed in order to determine the joint effect on academic achievement pre-test and post-test scores according to whether there is internet at home in the research groups, and the results of the analysis are presented in Table 3 and Table 4. The descriptive statistics of the achievement scores of the students participating in the research according to the variables of group and the presence of internet at home are given in Table 5.

Table 5.
The Descriptive Statistics of Achievement Scores According to the Group and the Presence of Internet Variables

Variable	Group	The presence of Internet	N	$\bar{X}$	SS
Achievement pretest	Experiment	There is no internet at home	4	15.00	2.94
		There is internet at home	32	13.84	3.86
		Total	36	13.97	3.75
	Control	There is no internet at home	6	15.33	1.36
		There is internet at home	31	15.61	1.56
		Total	37	15.56	1.51
Achievement posttest	Experiment	There is no internet at home	4	18.50	3.11
		There is internet at home	32	19.50	2.15
		Total	36	19.38	2.25
	Control	There is no internet at home	6	16.66	2.25
		There is internet at home	31	17.35	2.23
		Total	37	17.24	2.22

It is seen that the achievement pre-test scores of the students in the control group participating in the research are higher than the experimental group, while the achievement post-test scores are lower. In addition, it is understood that the achievement pre-test scores of the students in the control group who have internet at home and who do not have internet at home are higher than the students in the experimental group with and without internet at home. However, the opposite is true for the achievement post-test scores. Two-way multivariate analysis of variance (two-way MANOVA) is used to determine whether the common effects of group and the presence of internet independent variables make a difference on success, and the results of analysis are given in Table 6.

Table 6.
Two-Way MANOVA Results of Achievement Scores Based on the Presence of Group*Internet Variables

Effect	Wilks' Lambda	F	Hypothesis SD	Error SD	p	Partial η2
Group	.87	5.17	2.00	68.00	.008	.132
The presence of Internet	.97	.92	2.00	68.00	.402	.026
The presence of Group* Internet	.99	.36	2.00	68.00	.700	.010

When the common effects of the presence of group*internet variables are examined in Table 6, it is found that the dependent variables do not differ (Wilks' Λ=.990; F(2;68)=0.359, p>.05, η2=.010). It will be seen that the common effect of the presence of Group*Internet is small (η2=.010). Accordingly, the scores of the linear component of the achievement pre-test and post-test scores do not differ between the students in the experimental and control groups with and without internet at home.

Results Obtained from MANOVA Analysis of Academic Achievement Scores According to the Presence of Someone who helps with the Lesson at Home

Two-way multivariate analysis of variance was performed in order to determine the joint effect on academic achievement pre-test and post-test scores in the research groups according to whether there is a learning helper at home or not, and the results of the analysis are presented in Table 3 and Table 4. The descriptive statistics of the achievement scores of the students participating in the research according to the variables of being a group and the presence of someone who helps with the course are given in Table 7.

It is seen that the achievement pre-test scores of the students in the control group participating in the research are higher than the experimental group, while the achievement post-test scores are lower. It is also understood that the achievement pretest scores of the students in the control group who have both someone who helps at home and do not have someone who helps at home are higher than those of students who have and do not have someone who helps at home in the experimental group. However, the opposite is true for the achievement post-test scores.

Table 7.
The Descriptive Statistics of Achievement Scores According to the Variables of Group and the Presence of Someone who helps with the Course

Variable	Group	The Presence of Someone to help at home	N	X̄	SS
Achievement pretest	Experiment	There is nobody to help at home	15	13.40	3.44
		There is someone to help at home	21	14.38	3.99
		Total	36	13.97	3.75
	Control	There is nobody to help at home	21	15.52	1.72
		There is someone to help at home	16	15.62	1.26
		Total	37	15.56	1.52
Achievement posttest	Experiment	There is nobody to help at home	15	18.73	1.94
		There is someone to help at home	21	19.85	2.37
		Total	36	19.38	2.25
	Control	There is nobody to help at home	21	17.23	2.59
		There is someone to help at home	16	17.25	1.69
		Total	37	17.24	2.22

Two-way multivariate analysis of variance (two-way MANOVA) is used to determine whether the common effects of the group and someone who helps at home independent variables make a difference on success, and the results of analysis are given in Table 8.

Table 8.
Two-Way MANOVA Results of Achievement Scores Based on the Presence of Group*Support at Home Variables

Effect	Wilks' Lambda	F	Hypothesis SD	Error SD	p	Partialη2
Group	.70	14.57	2.00	68.00	.000	.300
Someone who helps at home	.98	.69	2.00	68.00	.503	.020
Group*Person who helps at home	.98	.61	2.00	68.00	.547	.018

When the common effects of the group*person helping at home variables are examined in Table 8, it is found that the dependent variables do not show differentiation (Wilks' Λ=.982; F(2;68)= .608, p>.05, η^2=.018). The common effect of group*person helping at home will appear to be small (η^2=.018). Accordingly, the scores of the linear component of the achievement pre-test and post-test scores do not differ between the students in the experimental and control groups with and without a person helping at home.

Conclusion and Discussion

When the results related to academic success in teaching the subject of Heredity according to the UDL model are examined in the study, it is seen that while the achievement pretest scores of the students in the control group are higher than the experimental group, there is a significant difference in the achievement post-test scores in favor of the students in the experimental group. Therefore, it is concluded that the lesson plans prepared and implemented according to the UDL model is effective in order to increase academic success. In this context, it can be said that the lesson plan prepared in conformity with the UDL guidelines and directions allows for an increase in academic success. It is shown in many studies that there are positive effects of science courses, in which universal design is applied in learning, on academic achievement (Dymond et al., 2006; Hitchcock et al., 2016; Tavares et al., 2021; Yu et al., 2021). The results of this study are consistent with the results that participation in the lesson, interacting with teachers and peer groups, working independently, giving the opportunity to show what they have learned in accordance with their individual needs, presenting the content in various ways, and being able to make self-assessment in the science lesson, in which UDL is applied, improve science academic success. (CAST, 2018; Johnson-Harris and Mundchenk, 2014; Rao and Meo, 2016).

Within the scope of the study, it is determined that the achievement pre-test scores of the students in the control group both with and without a computer at home are higher than the students in the experimental group with and without a computer at home. However, when the achievement post-test

scores are examined, it is seen that the academic achievement scores of the students in the experimental group are significantly higher than the students in the control group. When the common effects of computer presence at home in the experimental and control groups on whether it makes a difference on academic achievement are examined, there is no significant difference between students with and without computers. In addition, it is seen that these variables have a low effect together. It is known that taking advantage of the availability and accessibility of technology to support different student needs has become very important today. The benefits of technology integration in terms of differentiation, diversity of representation, motivation and participation, formative assessment and life skills are noted (Anderson and Putman, 2020). The effectiveness of the use of technology in the UDL has been shown in many studies (Hitchcock et al., 2016; Marino et al., 2014; Rappolt-Schlichtmann et al., 2013; Reyes et al., 2022; Tavares et al., 2021; Yu et al., 2021). The result of this research supports that multimedia applications (multimedia), which are used to create flexible environments that address the individual differences of students and to present information in alternative ways, have a positive effect on academic success. However, it is seen that there is no significant difference between the presence of computers / tablets at home and the absence of computers / tablets in the experimental group in terms of academic success in this study. According to this result, it is thought that the lesson plan prepared according to the UDL model may reduce the obstacle to learning due to the lack of technology tools such as computers / tablets at the student's home. This may be due to the fact that alternatives with and without technology tools have been offered for the post-class period, as recommended in the UDL applications.

When the research results are examined, it is understood that the achievement pre-test scores of the students in the control group both with and without internet at home are higher than the students in the experimental group with and without internet at home. However, there is a situation in favor of the experimental group in the achievement post-test scores. In addition, when the effect of internet presence at home on academic achievement in the experimental and control groups is examined, it is understood that there is no significant difference and the presence of the internet at home has a small effect. It has been shown in many studies that the presence of internet technology positively affects academic success in science education (Çetin and Günay, 2010; Sakız et al., 2014; Tekdal and İlhan, 2021; Yumuşak and Aycan, 2002). In addition, the effectiveness of the use of technology in the UDL has been shown in many researches (Dell et al., 2012; Hitchcock et al., 2016; Marino et al., 2014; Rappolt-Schlichtmann et al., 2013; Reyes et al., 2022; Tavares et al., 2021; Yu et al., 2021). The result of this research supports that using the internet in the classroom environment in the design of the education and training process increases academic success. However, when the effect of having or not having an internet connection at home of the students in the experimental group on their academic success is examined in this study, it is seen that there is no significant difference. According to this result, it can be said that the UDL increases academic success in the groups where it is applied, regardless of the presence of internet at home. It is thought that this situation is related to the practice of UDL's 'selection of accessible information sources and course materials for all students' in the course planning process.

According to the research results, it is understood that the achievement pre-test scores of the students in the control group who have both someone who helps at home and do not have someone who helps at home are higher than the students who have and do not help at home in the experimental group. However, there is a situation in favor of the experimental group in the success post-test scores. When the common effects of the presence of someone who helps at home in the experimental and control groups on whether they make a difference on academic achievement or not, there is no significant difference between the students. In addition, it is seen that these variables have a low effect together. According to Vygotsky, one of the representatives of the constructivist approach, the people around them have an important place in the knowledge and thoughts of children and in the acquisition of various skills (Çakıcı, 2010). Therefore, it will be a facilitating factor for students to work in cooperation with adults or peers (Krause et al., 2003). The effectiveness of this approach has been noted in many studies (Burgstahler, 2020; CAST, 2018; Landry-Cuerrier and Migneault, 2009; Rao and Meo, 2016). The result of this research supports that increasing both the interaction between the students and the teacher affects the academic achievement positively in UDL. In addition, within the scope of this study, when the common effects of the presence of someone who helps at home in the

experimental and control groups on whether they make a difference on academic achievement or not, it is seen that there is no significant difference between the students. According to this result, it can be said that in the groups in which UDL is applied, academic achievement increases independently of the presence of someone who helps at home. It is thought that this situation is related to the application of 'Classroom climate' and 'Interaction' factors in the learning process.

Implications

When the results of the study are considered, the suggestions presented are listed below:

- The implementation of the UDL model by teachers in the design of inclusive practices in rural areas for effective and efficient science education can increase success. In this context, teachers and pre-service teachers should be informed about lesson planning and implementation of activities in the learning environment according to the UDL model.
- The research has been conducted in a single school in Kars with 73 students. It is suggested to test and disseminate its effectiveness by applying it in larger samples at different school levels.
- A research can be carried out in which inclusive students will be included in order to obtain data on the comprehensiveness of the IET model in our country.
- The research is limited to the subject of Inheritance in the 8th grade in order to avoid loss of subjects during the pandemic process. It will be beneficial to carry out future researches on different subjects for a longer period of time in terms of more comprehensive results.
- Quantitative research methods are used in this study. Mixed methods can be applied to obtain more detailed results.

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Ethic statement: In this study, we declare that the rules stated in the "Higher Education Institutions Scientific Research and Publication Ethics Directive" are complied with and that we do not take any of the actions based on "Actions Against Scientific Research and Publication Ethics". At the same time, we declare that there is no conflict of interest between the authors, that all authors contribute to the study and that all the responsibility belongs to the article authors in case of all ethical violations.

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