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The effect of instruction designed with integral ASIE model on learning of genetics of preservice science teachers[1]

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Abstract. This study aims to examine the effect of the use of activities designed by the Integral ASIE Model to learning about genetics in third grade genetics and biotechnology class of preservice science teachers and to determine the opinions of preservice teachers regarding this model and implementation period. The research was conducted with the participation of 39 preservice teachers studying at third grades of the Department of Science Education, Faculty of Education at a State University in the spring semester of 2016-2017 education year. While the activities organized with the Integral ASEI Model were utilized for the preservice teachers included in the experimental group about learning genetics; the control group was explained about the project in line with the current science curriculum. According to the findings, it was concluded that the education designed according to Integral ASIE model in genetics had an effect on enhancing the academic achievement of science preservice teachers in terms of genetics. The content analysis of data obtained from semi-structured interviews applied to the preservice teachers in the experimental group support this result.

Keywords: Learning design, integral ASIE model, genetics, 21st century skills

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INTRODUCTION

The ever-changing and developing technology improves environment conditions for people to live a higher quality life and facilitates lives. This change and development in technology, closes has an effect on fields related to technology (Akkoyunlu, Altun and Soylu, 2008; Fer, 2011; Başak and Ayvacı, 2017). One of the conveniences provided by technology in our lives is access to information. This caused an explosion of information in all fields to occur in a short while. This rush of information contains as much accurate information as incorrect or missing information and the obtained information losses it currency fast and leaves its place to new ones (Akkoyunlu et al., 2008; Farokhi, Vahid, Nilashi and Branch, 2016; Fer, 2011). Such developments in information and access to information causes the definitions of qualifications and skills individuals should have. The qualifications and skills individuals should have in this age we are in has entered into literature under the title "Skills of the 21st Century" (Kang, Heo, Jo, Shin and Seo, 2010; Trilling and Fadel, 2009). As a result of this change and interaction caused by all such developments and change education aims to raise individuals who are equipped with information and knowledge that could cater to education, personal skills, research and knowledge acquisition skills, productivity, innovation and career skills, and technology skills that may meet the requirements of the new age and pathfinders that will enable such individuals to gain such skills (Germaine, Richards, Koeller and Scubert-Irastorza, 2016; Günüç, Odabaşı and Kuzu, 2013; Nissim, Weissblueth, Scott-Webber and Amar, 2016).

The findings of national studies in this respect also support the findings (Demir and Sezek, 2009; Erdoğan, Özsevgeç and Özsevgeç, 2014; Karagöz and Çakır, 2011).

[1]This study has been derived from the first author's master thesis and presented as an oral paper at 3rd World Conference on Science & Mathematics Education, August 28-30, 2017, Bahcesehir University, Istanbul, Turkey.

These problems in genetics also introduce new learning methods and technical research (Pekel and Hasenekoğlu, 2015; Smith, Wood and Knight, 2008). In short, the concept of instructional design concept defined as "use of systematic design processes" comes to forefront right at this point (Kemp, Morrison, Ross and Kalman, 2007).

The instructional design aims to develop effective and qualified learning systems for meeting education requirements and to present education systems that facilitate learning, are effective, productive, interesting and incentive (Fer, 2011; Jacovou-Johnson, 2014; Kemp et al., 2007; Şimşek, 2009). Various instructional design models that will act as a guide in effective and high quality learning as a result of the studies for instructional design were developed (Andrews and Goodson, 1980; Savenye, Olina and Niemczyk, 2001; Şimşek, 2009).

One of these models is the Integral ASIE model. The Integral Model, which is named after the initial letters of the steps included in the holistic approach and processes adopted by the design process consists of for main stages as Analyze, S: Strategize, I: Implement and E: Evaluate (Figure 1). The model, which started being designed in 2014, soon found itself a place among the literature (Zain, 2015b; Zain, Muniandy and Hashim, 2016).

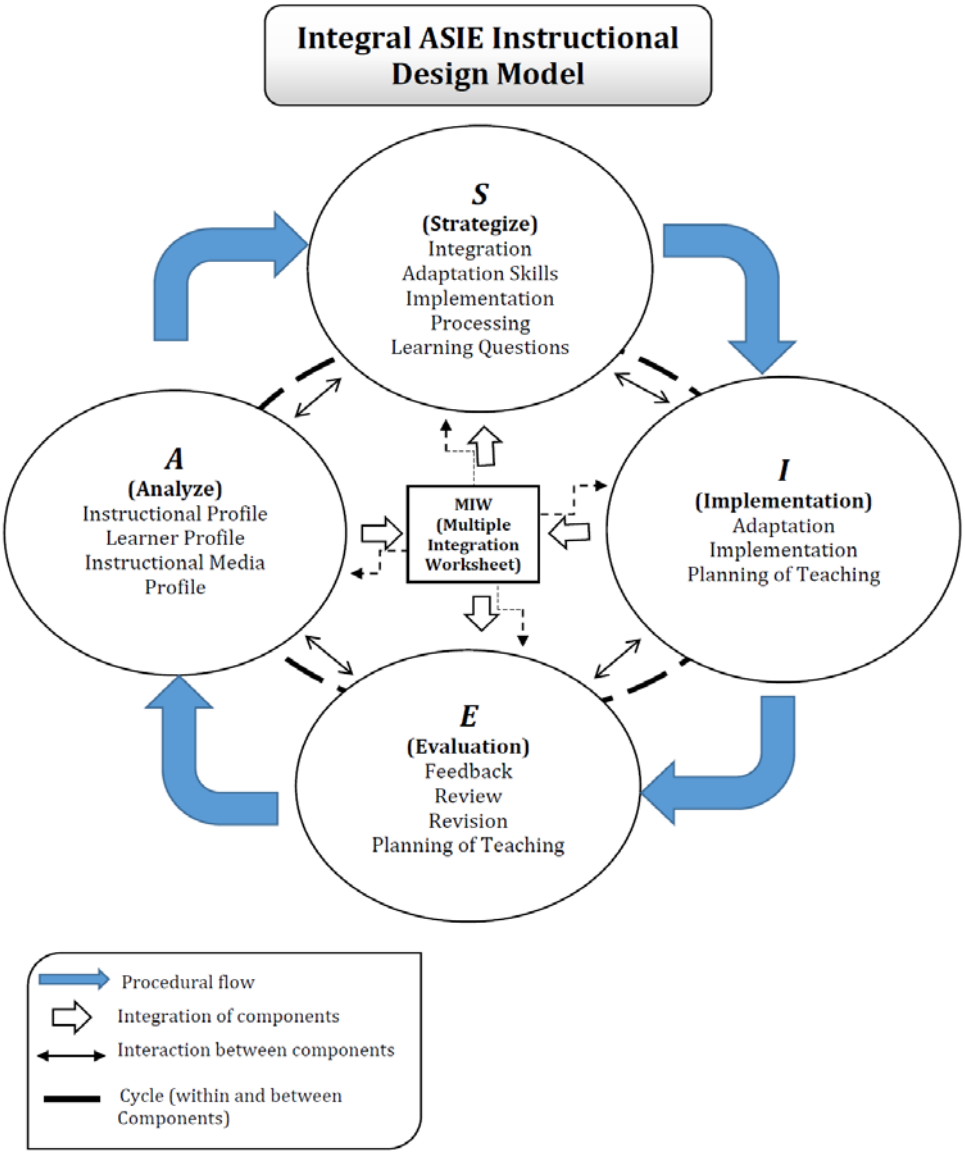

FIGURE 1. *Integral ASIE model (Zain et al., 2016)*

The Integral ASIE model resembles the Dick and Reiser Model in terms of development factors for determining and evaluating targets and purposes related to the designed education; to Dick and Carey Model in terms of development of education strategies and selection/development of learning materials and to ASSURE Model in terms of analysis of learners, determination of targets and selection of methods, medium and materials. While the Integral ASIE model resembles to Dick and Reiser, Dick and Carey and ASSURE instructional methods in terms of various factors, it is mainly based on the traditional ADDIE Model (Zain et al., 2016). The analysis, implementation and evaluation steps in the ADDIE Model are also included in the Integral ASIE model. The design and development steps in ADDIE Model has been approached with a holistic approach in the strategizing step in the Integral ASIE model.

The Integral ASIE model has a classroom-based instructional design model feature and stands out with its flexible and adaptable structure to learning environments of the 21st century. The most import feature that differentiates the Integral ASIE model, which shows a learner-focused structure, from other student-focused models is the Multiple Integration Worksheet [MIW]. MIW, which offers the design opportunity for both the teachers and the education designers at both a micro and micro level, was discussed under the title "Stages of Integral ASIE Model and MIW" and the MIW designed for the field of genetics was discussed under "Lecture Process in the Experimental Group".

Another important feature of the model is to include the 21st century learning skills determined by the Partnership for 21st Century Learning (P21) to instructional design process. The model, which took its place in the literature with the slogan of "21st Century Instructional Design Model", was designed especially for teachers, in addition to drawing attention with its focus on the 21 century skills, its adaptable structure from micro applications such as a single class hour to systemic macro applications and differs from other instructional design models (Zain, 2015a,b; Zain et al., 2016).

The Significance of the Research

Many methods and techniques are used in science education. In order for students to benefit most effectively from science lesson, learning environments need to appeal to as many sensory organs as possible and to too many mental functions. In other words, students cannot get adequate science education by just reading or seeing (watching) (Dewaters & Powers, 2006). Understanding of basic concepts in science course by students, associating them with daily life, replacing the concepts that are incorrectly formed in their minds with scientifically correct ones are among the primary objectives of this course.

In the Science Curriculum, which was updated in 2013, a research-inquiry based learning approach was adopted so that students could learn information meaningfully and permanently. With the strategies and methods determined accordingly, it is aimed to provide students with 21st century skills to meet the needs of the new age (Milli Eğitim Bakanlığı [MEB, Ministry of National Education], 2013). Later, in 2017, science education curriculum was updated again and a draft program was prepared by including science and engineering applications (MEB, 2017). In 2018, the curriculum was finalized and put into practice in all levels of secondary schools (MEB, 2018).

The importance of using new methods and techniques in science education is increasing day by day today. One of these innovations is the Integral ASIE model. In the literature, there are not many studies on the use of this model in science lessons. Since science lessons usually contain abstract concepts, it can be difficult to be understood by students. Therefore, the methods and techniques used by the teacher are extremely important for students to make sense of these concepts and in developing a positive attitude towards science subjects. One of these methods and techniques is the Integral ASIE Model, which enables the student to learn more easily, to be more enthusiastic for the lectures and offers the opportunity for learning to be realized more effectively. This model has a classroom-based instructional design and stands out with its flexible and adaptable structure to learning environments of the 21st century.

The subject of genetics, which is one of the science subjects, is one of the subjects that is hard to learn (Dehoff, 2010; El-Hani, 2014; Erdoğan et al., 2014; Karagöz and Çakır, 2011; Tsui and Treagust, 2003; Vickova et al., 2016). Developments from the determination of gene maps, synthetic tissue or organ production, stem cell studies, and early diagnosis of genetic diseases increase the importance of genetics day by day (Burke and Emery, 2002; Paz De Jesus and Mitchel, 2016) Therefore, in order to ensure that students and prospective teachers of the future learn genetics effectively, effective and efficient learning systems and appropriate learning environments should be designed. In this study, it is believed that the activities designed with the Integral ASIE model will help science preservice teachers to learn genetics more effectively. According to the results of the literature review, it was determined that very few studies in Turkey or abroad have been made on the effect of the instructional design model on academic achievement. In this respect, it is believed that this study will contribute to the literature on the effectiveness of the model in question.

Purpose of the research

The purpose of this research is to determine the effect of the use of activities designed with the Integral ASIE model on the academic achievement of preservice teachers in learning of the genetics within the scope third grade genetics and biotechnology course and to examine the opinions on the implementation process. For this purpose, the problem of the research is expressed as "What is the effect of the Integral ASIE model on the science preservice teachers' learning genetics and what are their opinions on the implementation process?" Within the framework of this basic problem, answers to the following questions were sought.

1. Is there a statistically significant difference between the pre-test scores of the preservice teachers in the control group and in the experimental group?
2. Is there a statistically significant difference between the post-test scores of the preservice teachers in the control group and in the experimental group?
3. What are the opinions of the preservice teachers in the experimental group regarding the implementation process?

METHODS

This section includes the model of the research, the study group, the design and implementation process of teaching, the tools used in data collection, the development and implementation process of these tools, and the statistical analysis techniques used in the analysis of the data obtained.

Research Model

The research was conducted based on a mixed type research approach, using both qualitative and quantitative approaches. The use of qualitative and quantitative data collection tools together in the mixed approach adds richness to the research and also the weakness of one approach can be covered with the strength of the other. This enables the results to be handled from a wider angle and more accurately (Creswell and Clark, 2007; Çepni, 2010). In this research approach, quantitative data were collected as the first stage and then qualitative data were collected in order to detail and explain these quantitative data as the second stage (Cresswell, 2008). In this study, researchers aimed to provide data triangulation, a total of efforts to increase the credibility of the research results by using a mixed research pattern (Yıldırım and Şimşek, 2011).

In the research, experimental design with pre-test, post-test control group was used to determine the effects of the activities designed with the Integral ASIE model on the academic achievement of preservice science teachers in genetics. Experimental methods are used in order to determine cause-effect relationships between variables that can be measured quantitatively. Within the framework of the qualitative dimension of the research, semi-structured interview, which is one of the qualitative research methods, was used in order to determine the opinions of preservice teachers about the teaching designed with the Integral ASIE model. Semi-structured

interview is used to specify people's opinions on a subject and the reasons thereof (Çepni, 2010). In this respect, one of the two branches of third grade science education undergraduate program was deemed as the experimental and other as the control group. While teaching in the control group was carried out with applications suitable for the current science curriculum, the experimental group was carried out with activities designed with the Integral ASIE model. The experimental pattern used in the research is provided in Table 1.

Table 1. *Experimental model of the research*

Groups	***Pre-test***	***Implementation***	***Post-test***
Control	Learning Styles Test (LST) Genetic Achievement Test (GAT)	According to the current Science Education Undergraduate Curriculum	Genetic Achievement Test (GAT)
Experiment	Learning Styles Test (LST) Genetic Achievement Test (GAT)	According to the Activities Designed with Integral ASIE Model in addition the current Curriculum	Genetic Achievement Test (GAT) Semi-Structured Interview (SSI)

Study Group

The research was conducted with 39 third grade preservice teachers studying in two branches in the undergraduate program of the department of science education, Faculty of Education, a State University, in the spring semester of the 2016-2017 academic year. The demographic characteristics of the preservice teachers in the study group are shown in Table 2.

Table 2. *Demographic characteristics of prospective teachers in the study group*

Group	**Average Age**	**Gender**			
		Female		***Male***	
		N	**%**	**N**	**%**
Control	21.31	12	30.77	5	12.82
Experiment	20.55	19	48.72	3	7.69
Total and Percentage (%)		31	79.49	8	20.51

The study group consists of 39 preservice teachers, 17 of whom are in control and 22 are in experimental group. 31 (79.49%) of these preservice teachers are women and 8 (20.51%) are men. The average age of the control group is 21.31 and the average age of the experimental group is 20.55. Convenient sampling method was used in order to determine the study group. This method is deemed as a method that facilitates the researcher's efforts in terms of time, labor and cost (Marshall, 1996). One of the most important reasons for why preservice teachers were selected as the study group is that the instructional design model used was developed especially for teachers/preservice teachers. In addition, the preservice teachers to be able to take part in the instructional design as both a learner, designer and practitioner enabled them to become the most suitable study group for this study. The preservice teachers forming the study group was determined on a voluntary basis before starting the research and the research continued.

Data Collection

This section provides information on the data collection tools used in the research and the development and implementation of these tools. The data collection tools used in the research are given below.

1. Learning Styles Test (LST)
2. Genetic Achievement Test (GAT)
3. Semi-Structured Interview (SSI)

Learning Styles Test (LST)

Within the scope of the analysis of the learners under the analysis step in the research, the Learning Styles Test (LST) published on the website of the Ministry of National Education (MEB) was used by editing (URL-1). LST consists of three main headings as visual, audio and tactile/kinesthetic and of 60 articles, with 20 articles under each main heading.

Genetic Achievement Test (GAT)

Genetic Achievement Test (GAT) was developed by researchers in order to determine the knowledge levels of preservice teachers on genetics before and after the implementation of activities designed with the Integral ASIE model in preservice teachers in the experimental and control groups. This test consists of 20 questions that were previously used in various exams carried out by ÖSYM (Student Selection and Placement Center) and some prepared by researchers in order to assess basic knowledge and problem solving skills of preservice teachers regarding genetics.

Validity and Reliability Study of GAT

An expert's opinion was sought in order to validate the GAT, which was originally designed to contain 22 questions and the current genetics and biotechnology curriculum was taken into consideration. The table of specifications regarding GAT prepared in this respect is provided in Table 3.

Table 3. *Table of specifications regarding the GAT*

			Cognitive Area						
Subject	**Sub-subjects**	**Outcomes**	**Knowledge**	**Grasping**	**Implementation**	**Analysis**	**Synthesis**	**Evaluation**	**Total**
		Concepts related to genetics	Q2 Q1	Q3 Q9 Q11					
	Main Concepts	Grasps the relationship between the concepts related to genetics	Q6 Q4	Q19 Q22					10
Mendel Genetics	**Genetic Properties of the gene** *Dominance *Codominance *Lack of dominance **Types of inheritance** *Monohybrid Inheritance * Dihybrid Inheritance *Gender-related inheritance	It analyzes the phenotype and genotype of the genes according to genetics. Discovers th e phenotype /genotype of the ancestor s of a living c reature who se phenotyp e/genotype i s given for a particular ge ne or group of genes.			Q5 Q10 Q8 Q7 Q12 Q15 Q21	Q20 Q13 Q17 Q18 Q16			12
					Total				**22**

GBT, which contains 22 questions at the beginning in line with the designed teaching and expert opinion, was applied to 84 preservice teachers in the fourth grade, who had previously taken the genetics and biotechnology course, for 55 minutes. The data obtained from the practice were analyzed by KR (Kuder Richardson)-20 method and the reliability rate of the test was calculated as 0.757.

Item analysis was used as a confirmatory factor in order to develop or to determine the questions that should be removed from the GAT test. GAT implemented for preservice teachers through item analysis was scored as "1" for each correct answer and "0" for each wrong/blank answer, and all preservice teachers' GAT data were ranked from highest to lowest. The upper 27% and the lower 27% group of the data in the ranking were determined and the item difficulty index (pj) and the item discrimination index (rj) of all the items in GAT were calculated (Table 4). Thus, the number of questions was reduced to 20 and GAT took its final form. GAT was finally tested for reliability and the KR-20 value was calculated and the KR-20 value was calculated as 0.772 (Table 4). In general, it is stated that the reliability coefficient of a test to be 0.70 and above is sufficient to deemed that test reliable (Büyüköztürk, 2011).

Table 4. *Reliability analysis results of the GAT*

N	$\bar{X}$	***Median***	***SS***	***Average Difficulty (pj)***	***Reliability (KR-20)***
20	7.191	15.819	3.977	0.399	0.772

Semi-Structured Interview (SSI)

Interviews frequently used in qualitative research can be conducted as unstructured, structured and semi-structured interviews (Çepni, 2010; Yıldırım and Şimşek, 2011). In the semi-structured interview technique, which was preferred for this research, questions are prepared beforehand, but the order of the questions can be changed according to the interview process or questions can be asked in more detail. This provides flexibility for the study in terms of qualitative data (Çepni, 2010). The draft for the semi-structured interview articles prepared in order to determine the opinions of the preservice teachers about the instructional design model used and the implementation process was also examined by an expert faculty member. Necessary corrections were made in accordance with the expert's suggestions and applied to the four preservice teachers in the experimental group on a voluntary basis for a total of 40 minutes. Semi-structured interview articles took their final shape according to this pre-implementation. The scores obtained by the preservice teachers in the GAT, which was applied as a post-test, were considered in determining the preservice teachers who will undergo the semi-structured interview consisting of four questions. Accordingly, preservice teachers were divided into three groups consisting of high, medium and low achievement levels according to their scores from GAT (Table 5).

Table 5*. Data on achievement groups formed according to the results of the GAT*

	Grade	***Achievement Level***	***Frequency (f)***	***Percentage (%)***
GAT	13-16	High	3	15
	9-12	Medium	12	60
	5-8	Low	5	25

Preservice teachers were informed that they will undergo a semi-structured interview on voluntary basis about their views on the teaching and instructional design model used for five weeks. Six preservice teachers, including two preservice teachers from each achievement group, who were willing to participate in the interview, were determined and the demographic characteristics of the preservice teachers are shown in Table 6.

Table 6. *Demographic characteristics of preservice teachers who underwent the SSI*

Semi-Structured Interview	Gender		Total
	Female	***Male***	
Frequency (f)	4	2	6
Percentage (%)	66.7	33.3	100

The preservice teachers to be interviewed were informed that audio records of the interview will be taken and brief information was given about the Integral ASI model used in teaching applied to preservice teachers. Then, the prepared questions were asked. The interviews were conducted in an environment deemed suitable by the preservice teachers in about an hour in order to help establish a suitable chatting environment and make preservice teachers feel more comfortable.

Validity and Reliability Study for the SSI

The questions related to the semi-structured interview applied with the aim of determining the preservice teachers' opinions about teaching designed with the Integral ASIE model were created by taking the opinion of an expert. Voice recordings were converted into written text in computer environment. These data were also examined by a specialist in the science education department along with the researchers and the language of the text was cleared from colloquial language without losing its meaning. The data were individually coded by researchers and one science specialist independently. The results of the assessment were compared, consensus and dissensus were calculated and the percentage of reliability was found via the formula proposed by Miles and Huberman (1994):

$$Percentage\ of\ Consistency\ (P) = \frac{Na\ (Consensus)}{Na\ (Consensus) + Nd\ (Dissensus)} X\ 100$$

Finding .80 or more as a result of the formula indicates that the evaluation is reliable (Miles, Huberman and Saldana, 2014). According to the formula, the percentage of compatibility between coders was calculated as 0.89. This result indicate that it is reliable to evaluate the questionnaire using different coders.

Instructional Design and Implementation

The subject of genetics within the scope of the genetics and biotechnology course in the science education curriculum was designed and applied according to the Integral ASIE model. Emails were exchanged with Dr. İsmail Md. ZAIN, one of the designers of the Integral ASIE model, before and during the design process; information was obtained from him regarding the design and implementation process of the model. The procedures carried out for each step of the Integral ASIE model are tried to be explained below.

Analysis

Analysis of the instructional profile, the learner profile and the instructional media profile were carried out in the first step of the integral ASIE model; the analysis step.

Analysis of Instructional Profile

Within the scope of the analysis of the instructional profile, the teaching step, course, subject, duration, learning area, goals and outcomes for which the teaching will be designed for were determined. Since the model was designed especially for teachers/preservice teachers, undergraduate level was chosen as the teaching step and preservice teachers were selected as the study group. Since genetics, included in the genetics and biotechnology course, one of the most important courses in the science education curriculum, is one of the subjects causing learning problems; it was selected as the subject for which education will be designed for. The implementation period of the education, which is designed for genetics in order to address the learning styles of preservice teachers, was determined as a total of five weeks, two lessons per week.

Learning outcomes determined by also obtaining an expert's opinion regarding genetics are presented below.

1. Defines the general concepts related to genetics.
2. Grasps the relationship between phenotype and genotype concepts.
3. Analyzes the phenotype and genotype that will occur in the offspring according to the genetic feature of the gene.
4. Solves the problems of genetic types by using the correct method.
5. Discovers the phenotype/genotype of the ancestors of a living creature whose phenotype/genotype is given for a particular gene or group of genes.

Analysis of Learner Profile

LST was applied in order to determine the learning styles of the study group for the analysis of the learner profile. Each learning style was evaluated over 20 points, each item being 1 point. The Learning Styles Test data applied to the experimental and control groups are shown in Table 7.

Table 7. *Learning style test results*

Group	***Learning Style***		
	Visual	**Audio**	**Tactile/Kinesthetic**
Control	10.69	5.62	6.46
Experiment	9.33	5.85	6.22

When the data in Table 7 are considered, it was determined that the preservice teachers in both the experimental and control groups have a visual weighted learning style. Studying suggestions (URL-2) according to learning style, which has been published on MEB's website by Van Gevaş Secondary School, were edited and distributed to the teachers in both experimental and control groups, according to the learning style they possess together with the test results.

Determination of Instructional Media Profile

In determining the instructional media profile, the media types, items, and the object, background and emotional profiles under the title of the structure in accordance with the characteristics of the learners was tried to be specified. In the teaching designed in the light of the data obtained from the profile analysis of the learners, visual-weighted materials were tried to be designed since it was determined that the majority of preservice teachers have a visual learning style. Accordingly, it was decided to use illustrated lecture notes, models, presentations, videos, and music.

Strategizing

The stages of integration, adaptation, implementation, processing and formulation in the strategizing step, which is the second step of the model, are designed by researchers as follows.

Integration

At this stage, studies on how to use the instructional media determined according to the characteristics of the learners were carried out, and accordingly, media selection and design studies were carried out by the researchers in accordance with the theoretical information in the content of genetics. The materials and processes related to the design processes designed by the researchers according to the Integral ASIE model are tried to be explained below.

Genetics Lecture Notes (GLN)

A GLN, consisting of eighteen pages, was designed to include basic theoretical information to meet the learning objectives and outcomes determined within the scope of genetics. An expert's opinion was sought for each factor from the theoretical information in the lecture notes to the pictures and practice questions used and arrangements were made when and where necessary.

DNA Model

The material (Photo 1) designed by the researchers to materialize the bases in the DNA helix and the structure formed by deoxyribose sugar was also used as the reward of the interim evaluation carried out at the end of the first week.

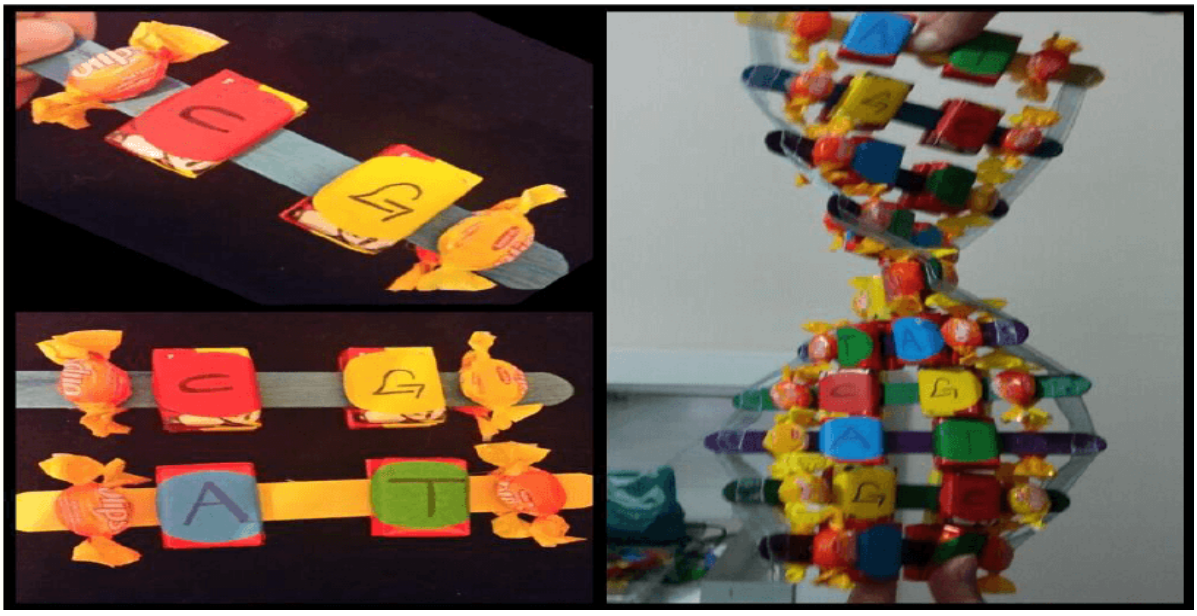

Photo 1. *Visual example of the design process of a DNA model*

Magnetic Bases

STEM technique was used in the design and development of this material. STEM technique was used in the research by integrating it into the Integral ASIE model. Accordingly, magnetic bases were designed to represent the bases in the DNA helix (Photo 2). The opposite poles (N–S) of the magnets were arranged according to the bonding of the bases with each other.

Photo 2. *Visual example of the design process of a DNA model*

Chromosome Model

Chromatids, designed from wire and sponge beads in order to materialize the chromosome structure, are designed so that they can be attached to each other by the magnet placed in the centromere region (Photo 3).

Photo 3. *Visual example of the design process of a chromosome model*

Presentations

The lecture presentations developed in order to support genetic lecture notes were prepared using the Prezi presentation program (Photo 4). In this presentation program, slides are supported by zooming in and out, motion effects and spatial relationships can be established between slides. This enables the design of more visually striking presentations.

Photo 4. *An example of a visual of the presentation prepared with Prezi presentation program*

Videos

The videos, which were used as supporting materials, are integrated into the Prezi presentations prepared to be used as a repeat element after the related topics (Photo 5).

Photo 5. *An example of a visual of the videos prepared with Prezi presentation program*

Music

Music was used as background music in videos in this research. In addition, Mozart's "Turkish March" and "K448" pieces were prepared to be used in the implementation process based on the researches in the literature describing the "Mozart Effect".

Adaptation

The materials designed within the scope of the instructional media and the procedures determined regarding the use of these materials were adapted to the 21st century skills and thinking skills in the adaptation phase.

Implementation

The thinking tools, methods, techniques and activities suitable for 21st century learning and thinking skills were determined in the implementation stage and the teaching was designed accordingly.

Processing

The aim is for the learners to internalize the subject in the processing stage. While theoretical information about genetics was provided in this respect; the subject was tried to be associated with daily life and suitable examples were given.

Formulation

At this stage, questions for metacognitive area and questions related to the sub-cognitive area were designed under the title of teaching questions. The designed questions were used for interim evaluation during the processing of the subjects and at the end of the courses.

Implementation

The implementation process was conducted by the researchers for a total of five weeks, two lessons per week in a theoretical level in the experimental and control groups, and data on the implementation process are summarized in Table 8.

Table 8. *Weekly distribution of subjects in experimental and control groups*

Week	***Subjects***
1	*Introduction to Genetics* *The Purpose of Genetics* *Mendel Genetics/Classical Genetics* *Molecular Genetics* *Population Genetics* *Mendel's Genetics Laws*
2	*Monohybrid Genetics* *Deviations from 3:1 Phenotypic Ratio* *Sample Problems*
3	*Dihybrid Genetics* *Deviations from 9:3:3:1 Phenotypic Ratio* *Sample Problems*
4	*Sex Determination in Humans* *Sex Chromosome Anomalies* *Genetics Related to Sex Chromosomes* *Diseases Transmitted by Gender-Related Genes* *Diseases Transmitted by Holandric Genes* *Sample Problems*
5	*General Overview* *Problem Solving*

The procedures carried out for the implementation stage were tried to be explained separately for the experimental and control groups.

Lecture Process in the Control Group

Before starting the lecture in the experimental group, the previously developed GAT was applied as a pre-test and the designed GLN was distributed to preservice teachers in the control group. The theoretical bases of the courses were carried out in line with these notes and parallel to the experimental group (Photo 6).

Photo 6. *An example of a visual of the lectures taught to the control group*

After the lectures were carried out for five weeks, a repetition took places in the last week for the subjects that were not understood by the preservice teachers. Then, GAT was applied as post-test afterwards.

Lecture Process in the Experimental Group

The lectures in the experimental group were designed and conducted according to the implementation step; the third step of the model. Accordingly, in accordance with the data obtained from the first two steps of the model and the strategies determined, lecture plans were

developed and implemented based on MIW. MIW (multi-integration worksheet) for teaching genetics in accordance with the Integral ASIE model is summarized in Table 9.

Table 9. *Multiple integration worksheet (MIW) prepared for the subject of genetics*

ANALYSIS		
Instructional Profile	***Learner Profile***	***Instructional Media Profile***
Grade: 3 ***Lecture:*** Genetics and Biotechnology ***Subject*****:** Genetics ***Term*** 5 Weeks ***Learning Area*****:** In-class (technology supported) ***Learning Targets*****:** Mainly cognitive, affective and psychomotor ***Learning Outcomes*****:** Given under the title of analysis.	***Learning Styles*** Which learning style the learners had was determined with the Learning Style Test (LST).	***Media Types*****:** Picture Slide Video Music ***Elements*****:** GAT Prezi presentations, Videos ***Structure*****:** Chromosome Model DNA Model Magnetic Bases
STRATEGY		
Integration	***Adaptation***	***Implementation***
Instructional Media Nested Procedures Procedures for the use of the designed materials were determined.	***21st Century Learning and Thinking Skills*** Arrangements were made for preservice teachers to gain 21s century learning and thinking skills.	***Thinking Tools*** Bloom Reason result De Bono (Lateral Thinking) PMI Brainstorming ***Methods, Technique and Activities*** Mozart Effect STEM In the lecture process; Presentation method Invention method Problem Solving Individual/Teamwork methods were used.
Process		**Formulation**
Values By establishing a connection between the subject and daily life, preservice teachers were enabled to internalize what they learned.		***Instructional Questions*** **Questions for Metacognitive Area** They were mainly used in interim evaluations. **Questions for Sub-Cognitive Area** They were mostly used when the subject was being taught and at the end of the subject.

The procedures regarding the implementation process of the courses are shown below in weeks.

First Week's Lectures

Before starting the lecture, the previously developed GAT was applied as a pre-test and GLN was distributed to preservice teachers. In line with the designed lecture plan, subjects related to introduction to genetics were covered with the support of GLN, Prezi presentation, chromosome model, magnetic bases and DNA model.

Second Week's Lectures

In the second week, "*monohybrid genetics"* and "*deviations from the 3:1 phenotypic ratio"* subjects were covered with the support of GLN, Prezi presentation and videos. After completing the theoretical part of the course, problems related to the subject were solved and the Kahoot program was used as an interim evaluation tool.

Third Week's Lectures

In the third week, "di*hybrid genetics"* and "*deviations from the 9:3:3:1 phenotypic ratio"* subjects were covered with the support of GLN, Prezi presentation and videos. Deficiencies were determined over the results of the interim evaluation on "*monohybrid genetics*" from the previous week. Additional worksheets were prepared for preservice candidates for *"monohybrid crossing"* and distributed to them at the beginning of the lecture, and a short overview was given at the beginning of the lecture. Since *"deviations from the 9: 3: 3: 1 phenotypic ratio"* subject is more complex than the others, Mozart's Turkish March was listened by the preservice teachers for a few minutes before beginning.

Fourth Week's Lectures

In the fourth week, the issues of *"sex determination in humans", "sex chromosome anomalies and gender related genes"* and *"diseases transmitted by holandric genes"* were covered with the support of GDN, Prezi presentation and sample problem solutions. Problems related to the subject were solved at the end of the lecture and finally interim evaluation was made with Kahoot program between the groups.

Fifth Week's Lectures

After the theoretical part of the last week of the implementation was completed, the preservice teachers were asked about the subjects they did not understand and had problems with regarding genetics and the related subjects were reinforced by repeating according to the feedback received. Then, the prepared Genetic Achievement Test (GAT) was applied to preservice teachers as a post-test.

Evaluation

In the evaluation step, the last step of the model, both interim evaluations and main evaluation were made. Explanations regarding the evaluation processes are given below.

Interim Evaluations

Kahoot program was used for interim evaluations. The questions related to the subjects, which were covered every week, and mostly prepared for high level thinking skills, were asked to preservice teachers online through the Kahoot program. Kahoot program is a free and game based learning platform. Users can instantly register to the program with a nickname, and since they do not have to register under their own name, they can answer questions more comfortably. Users can answer the questions they read on the smart board by selecting the relevant option on their mobile phones. The program ultimately identifies the candidate/group that gives the fastest and the most correct answers. A small gift was presented to the candidate/group, who came in the first each week, and in this respect, the program was also used as a motivating factor. Preservice teachers were informed about the program and its use at the beginning of the first lecture to show how the program works. The Kahoot program, which was used for interim evaluation and motivation in order to determine whether there is a difference between the opinions of the preservice teachers regarding the Genetics and Biotechnology lecture before and after the teaching applied to the experimental group, was applied before continuing with the interim evaluation of the first week and after the end of the implementation.

The following questions were asked to preservice teachers via the program and the response time for each question was determined as 60 seconds.

Question 1. What do you think about the Genetics and Biotechnology course?

Question 2. What do you think about the degree of difficulty of this course? The answers given to the preservice teachers before and after the implementation are summarized in Table 10.

Table 10. *The opinions of preservice teachers about genetics and biotechnology courses before and after implementation*

Questions	***Answers and Percentages***				
What do you think about the Genetics and Biotechnology course?		*I seriously don't like it*	*I don't like it*	*I like it*	*I like it very much*
	Before	12.4	29.2	29.2	29.2
	After	5.5	27.8	27.8	38.9
What do you think about the degree of difficulty of this course?		*A very difficult course*	*Difficult lesson*	*Easy lesson*	*A very easy course*
	Before	20.8	29.2	37.5	12.5
	After	0	47.1	35.3	17.6

When the data in Table 10 are examined, it is observed that while 12.4% of preservice teachers stated that they did not like genetics and biotechnology course before the implementation and this rate decreased to 5.5% after the implementation. The rate of preservice teachers (29.2%) who stated that they liked the genetics and biotechnology course was increased (38.9%) after the implementation. While 20.8% of the preservice teachers regarded the course as very difficult before the implementation, no preservice teachers candidate deemed the course as very difficult after the implementation. The rate of preservice teachers who regarded genetics and biotechnology course as very easy before the implementation (12.5%) increased after the implementation (17.6%).

Main evaluation

The main evaluation was carried out in order to determine whether the goals set were achieved or not because of the implementation of the designed education or to what extent; how much of the instructional requirements were met. GAT was used as the main evaluation tool in the research.

Data Analysis

This section covers the processes related to the analysis and interpretation of the qualitative and quantitative data of the research and the analysis methods used in these processes.

Analysis of Quantitative Data

LST and GAT were used for the collection of quantitative data. Frequency and percentage distribution were used to analyze the data obtained from the LST and the demographic characteristics of preservice teachers. SPSS 22.0 statistics package program was used for the analysis of data obtained from GAT. The normality test was conducted in order to determine whether the data obtained from the study group with GAT are suitable for normal distribution; since the number of observations is less than 29, Shapiro and Wilk (1965) test results were evaluated and the data obtained are shown in Table 11.

Table 11: *The normality test results of data obtained from GAT*

GAT	***Group***	***N***	$\bar{X}$	***SS***	***p***
Pre-test	Control	17	26.177	14.310	0.170
	Experiment	22	25.909	9.466	0.037
Post-test*	Control	16	30.625	16.721	0.012
	Experiment	20	50.250	12.511	0.654

**2 preservice teachers in the experimental group and 1 in the control group could not attend the post-test due to private reasons.*

When the normality test results provided in Table 11 are analyzed accordingly, it was observed that the data obtained from results of the pre-test of GAT experimental group and the post-tests of the control group did not fit the normal distribution (p<.05), while the pre-test results of the control group and the post-test results of the experiment group fit the normal

distribution (p>.05). The Central Limit Theorem, which is based on the assumption that the distribution does not deviate excessively from the normal distribution because the number of preservice teachers in the experimental and control groups is below 30, is invalid for this sample (Kalaycı, 2010; Büyüköztürk, 2011). In addition, according to the test results, since the distribution of the data in the subgroups is not normal, the use of non-parametric tests in the solution of the problems related to the research was preferred and the findings were interpreted at the level of 0.05 significance. Findings obtained by analyzing quantitative data are included under the heading "Findings and Interpretation".

Analysis of Qualitative Data

Semi-structured interviews were held in order to determine the opinions of preservice teachers about Integral ASIE model and implementation process used in learning about genetics. Content analysis was used in the analysis of the data obtained. The concepts and relationships that can explain the data collected through content analysis are tried to be revealed (Yıldırım and Şimşek, 2011). The qualitative data obtained in this manner were coded separately by the two coders, and the codes were combined in line with the common cases they defined, and themes were created.

FINDINGS

In this section, the findings obtained as a result of analyzing the data obtained by qualitative and quantitative research methods are presented in relation to the sub-problems of the research.

Findings and Interpretation from Quantitative Data

In the study, the findings obtained by analyzing the quantitative data obtained with GAT were interpreted by associating them with the first and second sub-problems of the research.

Findings and comments on the first sub-problem

First bub-problem: *Is there a statistically significant difference between the pre-test scores of the preservice teachers in the control group and in the experimental group?* Considering that the data obtained from the GAT results applied to both experimental and control groups did not show a normal distribution in all sub-data groups, it was decided to analyze with non-parametric tests of data obtained in order to determine whether there is a significant difference between GAT results, which was used as the pre-test results of preservice teachers. Accordingly, the results obtained from the data analyzed by the Mann-Whitney U test are summarized in Table 12.

When Table 12 is examined, it is observed that there is no statistically significant difference between experiment and control groups according to GAT pre-test results (U=178.50; p>,05). This finding indicates that pre-knowledge levels of preservice teachers in the experimental and control groups before the implementation are close to each other, so that the determined experimental and control groups are suitable for the purpose of the study in this sense.

Table 12. *Mann-Whitney U test results regarding pre-test results of GAT of preservice teachers*

Group	***N***	***Rank Average***	***Rank Total***	***U***	***p***
Control	17	19.50	331.50	178.50	,806
Experiment	22	20.39	448.50		

Findings and comments on the second sub-problem

Second sub-problem: *Is there a statistically significant difference between the post-test scores of the preservice teachers in the control group and in the experimental group?* After the implementation process of the research was completed, the data obtained from preservice teachers' GAT post-test scores were analyzed with the Mann-Whitney U test in order to determine whether there was a statistically significant difference between the preservice teachers in the

experimental and control groups in terms of GAT post-test scores. The results from the test are summarized in Table 13.

Table 13. *Mann-Whitney U test results regarding post-test results of GAT of preservice teachers*

Group	*N*	*Rank Average*	*Rank Total*	*U*	*p*
Control	16	11.16	178.50	42.50	,000
Experiment	20	24.38	487.50		

When Table 13 is examined, it is observed that there is a statistically significant difference between the GAT post-test scores of the experimental and control groups at the end of the implementation (*U*=42,50; *p*<, 05). When the average ranks are taken into account, it is observed that the achievement of preservice teachers in the experimental group is higher than in the control group. When Tables 12 and 13 are examined together, while the achievement levels of the experimental and control groups regarding genetics did not show a significant difference, it is observed that there is a significant difference in favor of the experimental group after the implementation. This indicates that the academic achievement of the preservice teachers in the experimental group, where the activities designed according to the Integral ASIE model were carried out, are higher than those in the control group.

Findings and Interpretation from Qualitative Data

In the study, the data obtained from the semi-structured interviews conducted with six preservice teachers in three achievement groups determined according to the post-test GAT results from the preservice teachers in the experimental group were subjected to content analysis. The findings obtained in line with the codes and themes obtained as a result of analyzing the data with content analysis were interpreted by associating them with the third sub-problem of the research.

Findings and comments on the third sub-problem

Third bub-problem: *What are the opinions of the preservice teachers in the experimental group regarding the implementation process?* After the teaching applied to the experimental group, the examples of the percentage and frequency values of the themes and codes obtained from the content analysis of the preservice teachers' opinions on the Integral ASIE model used in the research and teaching designed with this model, and the examples of the opinions of the preservice candidates on these codes are given under the related headings. While the statements based on the determination of the codes are presented, the semi-structured interview order of the interviewed preservice teachers is ranked as (T1-T6).

Codes obtained under the model theme

Examples of statements of preservice teachers regarding codes determined under the model theme are shown in Table 14.

Table 14. *Frequency and percentage rates of codes obtained under the model theme*

	Model		
Codes	***Frequency (f)***	***Percentage (%)***	***Example Statements***
Fun	3	50	"Overall it was nice, we enjoyed it. It also motivated us. Perhaps genetics was a lesson I was afraid of. Now that I have learned something that I have seen in the classroom, it has allowed me to make a little more effort and to show more interest to it"(T2).
Different	3	50	
Motivating	3	50	
Instructional	2	33.33	"To be honest, I had no interest in the course. You know, there are matches, for example but I know more or less now, I can do crosses"(T3).
Nice	2	33.33	

Table 14. Continued

Reinforces interest	2	33.33	"It is very convenient, useful and encouraging. When there was a different method in this lesson, we were more interested"(T5).
Positive attitude towards the course	1	16.66	
Better than the current education	1	16.66	
Suitable	1	16.66	
Practical	1	16.66	
Interesting	1	16.66	
Offers the ability to improve one's self	1	16.66	
Helps remembering	1	16.66	
Facilitating	1	16.66	

According to Table 14, 50% of preservice teachers defined the Integral ASIE model as fun, different and motivating, while 33.33% defined it as nice, instructive and reinforcing interest. In addition, according to 16.66% of preservice teachers, the model defined the attitude towards the course as a positive modifier, better than the current education, convenient, interesting, offering self-improvement, memorable and as an easy model.

Codes obtained under the material theme

Examples of statements of preservice teachers regarding codes determined under the material theme are shown in Table 15.

When Table 15 is examined, 66.66% of the preservice teachers stated that they found the materials used to be good, and 50% of them found it nice, interesting and childish. While 33.33% of preservice teachers defined materials as encouraging and memorable, 16.66% defined them as effective, helpful to grasp, practical, versatile, entertaining, instructive and making it easier to learn.

Table 15. *Frequency and percentage rates of codes obtained under the material theme*

		Material	
Codes	***Frequency (f)***	***Percentage (%)***	***Example Statements***
Good	4	66.66	"It is encouraging in terms of materials" (T1). "The chromosome caught our attention, we liked it very much. So were the magnets"(T2). "The slides had not caught our attention. Because our main learning style is visual. We grasped them well, it was useful." (T2) "Materials were good. It felt like toys because they were never given before, but then together with the course, they were so good." (T3) "It has been 1.5-2 months since we have seen, but it is still somehow in my mind right now" (I5).
Interesting	3	50	
Nice	3	50	
Childish	3	50	
Encouraging	2	33.33	
Helps remembering	2	33.33	
Effective	1	16.66	
Helps grasping	1	16.66	
Practical	1	16.66	
Versatile	1	16.66	
Fun	1	16.66	
Instructional	1	16.66	

Makes it easier to learn	1	16.66

Codes obtained under the interim evaluation theme

Examples of statements of preservice teachers regarding codes determined under the interim evaluation theme are shown in Table 16.

Table 16. *Frequency and percentage rates of codes obtained under the interim evaluation theme*

Interim Evaluation			
Codes	***Frequency (f)***	***Percentage (%)***	***Example Statements***
Nice - not creating a fear of exam	5	83.33	"If you said you would directly do an exam, for example, we would have been afraid" (T1). "It was very useful when the teacher implemented it, we participated in the evaluation on our own phones. However, secondary school students cannot use the phone or participate in the evaluation because phones are prohibited in school"(T5). "It was nice to do it at the end of the course and the evaluation not to be in the form of a paper. For example, when our other teachers say take out the papers we'll do an exam at the beginning or at the end of the lesson… You know"(T6).
Motivating	3	50	
Like a game	2	33.33	
Competition	2	33.33	
Limited time	2	33.33	
Interesting	1	16.66	
Helps remembering	1	16.66	
Practical	1	16.66	
Not suitable for secondary education	1	16.66	
Suitable for the group used	1	16.66	
Fun	1	16.66	

When Table 16 is examined, 83.33% of preservice teachers stated that the interim evaluations were nice because they did not cause fear of exams, while 50% stated that they were motivating. 33.33% of preservice teachers stated that they found the interim evaluations like a game and that it created a competitive environment.

While 33.33% of the preservice teachers stated that the time given in the interim evaluation was not sufficient, 16.66% stated that the interim evaluation used was suitable for the implementation group, and 16.66% said it was not suitable for secondary education because phones are prohibited in secondary education. On the other hand, 16.66% of preservice teachers defined interim evaluations as interesting, helpful to remember, useful and entertaining.

Codes Obtained Under Lack of Infrastructure Theme

Examples of statements of preservice teachers regarding codes determined under the lack of infrastructure theme are shown in Table 17.

Table 17. *Frequency and percentage rates of codes obtained under the lack of infrastructure theme*

Lack of Infrastructure			
Codes	***Frequency (f)***	***Percentage (%)***	***Example Statements***
Internet	5	83.33	"There were sometimes problems with smart boards and the internet on the slides" (T1).
Smart board	2	33.33	"Everyone also has the Internet. It is just the

	pause of the smart board."(T2).

Internet and smart board problems are the main problems encountered in practice due to lack of infrastructure. According to Table 17, 83,33% of the teacher candidates stated that they experienced difficulties with the internet and 33,33% from the smart board during the implementation process.

Codes obtained under the negative aspects theme

Examples of statements of preservice teachers regarding codes determined under negative aspects theme are shown in Table 18.

Table 18. *Frequency and percentage rates of codes obtained under the negative aspects theme*

Negative Aspects			
Code	***Frequency (f)***	***Percentage (%)***	***Example Statements***
Video recording	5	83.33	"When there was a camera in the classroom, we were a little more reluctant (T1). It would be better if there was a hidden camera"(T2). I had problems with the camera." (T6)

According to Table 18, 83.33% of preservice teachers stated that they were reluctant due to video recording.

Codes Obtained Under the Theme of Using the Integral ASIE Model

Examples of statements of preservice teachers regarding codes determined under the use of Integral ASIE model theme are shown in Table 19.

Table 19. Frequency and percentage rates of codes obtained under the use of Integral ASIE Model theme

Use of Integral ASIE Model			
Code	***Frequency (f)***	***Percentage (%)***	***Example Statements***
I'll use it	6	100	"I would like to use it. Because science is a complicated lesson" (T1). "I can use it, it gets more fun. I think students will be more enthusiastic" (T3). "I would definitely use this application in my classroom if I can" (T4). "I would like to use it. Because now there is a developing technology, a developing education system, changing models. Now students can grasp more information more quickly. This was a different model, a different practice. Students can improve themselves more" (T5).

According to Table 19, all preservice teachers stated that they wanted to use Integral ASIE model.

DISCUSSION and CONCLUSIONS

In this part of the research, the results obtained according to the findings obtained from the research are discussed by comparing the results of similar research in the literature. In addition,

based on the research conducted, some suggestions for similar research to be carried out in the future are presented. The study examining the effect of the activities designed with the Integral ASIE model on the learning of the students of the science teaching program of genetics presented under the scope of the genetics and biotechnology course was carried out on the basis of a mixed research pattern, in which the qualitative and quantitative approach was handled together, and the results obtained in line with the findings of the GAT and SSI titles were presented under suitable headings.

Results and discussion obtained from the GAT

According to the GAT results, it was determined that there was no statistically significant difference between the pre-test scores and in terms of post-test scores of the experimental and control groups there was a significant difference in favor of the experimental group. This difference shows that teaching designed with the Integral ASIE model has an effect on academic achievement in science teacher candidates' learning genetics. In the literature review, very little research was encountered regarding the effect of the instructional design model used in the research on academic achievement. Therefore, the results are discussed in line with the ADDIE model on which the Integral ASIE model is based, the Dick and Carey model, which include certain elements and the ASSURE model (Zain et al., 2016).

Çetin (2019), in his study, aimed to examine the effect of using activities designed with the Integral ASIE Model on academic achievement of seventh grade science students and to determine the opinions of students in this class using this model. As a result of the research, it was determined that the Integral ASIE Model had a positive effect on students' academic achievement and education designed with this model is deemed as different, fun and has a rich information content.

Hadi et al. (2017) conducted a study that they developed on the basis of ADDIE instructional design model and the e-partograph module that instantly records the birth process integrated into the midwifery program. After the pilot application of the e-partograph was carried out with three students and the deficiencies were completed, it was implemented for 17 midwifery program third grade students. It is determined that the module developed according to the results of the study helps students to learn and increases the motivation of the students. It was determined that study for which the medical education curriculum was designed according to ADDIE instructional design model on chest radiography and applied to the first and second grade students of internal medical sciences for four weeks, was effective in meeting the requirements of the students studying the designed curriculum (Cheung, 2016).

In the study of Asuncion (2016) carried out in order to determine the effectiveness of the ADDIE model with second grade students of school teaching, , a project-based multimedia learning environment was designed in the education technology course for the 2015-2016 academic year. The results of the research indicate that the education designed with the ADDIE model significantly improves the performance of the participants in education technology. In the study of Ariefiani, Kustono, and Pathmantara (2016) in which they designed a learning module in accordance with the project-based learning approach according to the ASSURE model, they claim that the model does not only improved the cognitive, psychomotor and emotional aspects of the students, but also the ability to discover knowledge and teamwork in a project.

The research of Utama (2016) based on the Dick and Carey model, used the e-learning model developed in the research, where the accounting department of the Airlangga University designed the e-learning model to meet the information system needs, in database teaching. It is claimed that the designed e-learning model is an alternative teaching in optimizing learning. In the research of Kim and Downey (2016) using ASSURE model in order to integrate the technology into the school teaching program, 39 curriculums were applied for two years and the effect of the designed curricula on students' motivation to learn was examined. The research results support that the education designed according to the ASSURE model has a positive effect on the students and supports the conclusion that the ASSURE model is a practical, easily applied and effective

model in integrating the technology into school teaching. It is observed that the research results carried out with the instructional design models associated with the Integral ASIE model in the literature are similar to these research results.

Results and discussion obtained from the (SSI)

According to the findings obtained from the semi-structured interviews, while preservice teachers define the Integral ASIE model as fun, different, motivating, instructive and reinforcing attention, it was also stated that the materials designed in line with the model are interesting, a little childish at the beginning, and encourage them to remember what they learned. The preservice teachers stated that the interim evaluations used did not create a fear of exam, created a competitive environment and motivated them for the course. Accordingly, it is observed that both the Integral ASIE model and the materials and interim evaluations designed in line with the model positively affect the preservice teachers and contribute positively to qualified learning. These results support the results obtained from the quantitative data of the research.

Although preservice teachers noted that they had difficulties in practice due to lack of infrastructure, internet and the smart board, and they were reluctant due to video recording, all of the preservice teachers stated that they wanted to use Integral ASIE model. Although there were various problems in practice, the preservice teachers' wish to use the Integral ASIE model created the opinion that these problems did not affect the study to a great extent and suggestions for these deficiencies were presented under the “suggestions” heading.

Apart from Zain et al. (2016) and Çetin’ (2019), study, no research on the Integral ASIE model has been encountered in the literature review. In this research conducted on the Integral ASIE model, the Integral ASIE model was deemed as clear (59%), appropriate (67.62%), useful (72.38%), supporting the development of knowledge and skills (66.67%) and meeting educational needs. (62.86%). In the study conducted with preservice science teachers, it was observed that preservice teachers’ definitions related to the model mostly coincide with the definitions obtained in this study (Zain et al., 2016).

As a result, the Integral ASIE Model differs from other instructional design models as most instructional design models are system-based models designed to develop an instructional system. The process of presenting the designed activities by the teachers is considered and they are mostly teacher-centered. In these models, answers to the question such as what the teacher should give/should offer is sought and are for the design process of teaching. Whereas, the Integral ASIE Model is specially designed for the specific course. Students' requests, learning strategies, learning conditions are considered and it is student-centered. Students participation and interactions are essential as a result of students 'cooperation and communication. It also includes flexible design elements that allow customization for the current situation, and with the online version, elements required can be easily added and removed. It was determined in this study that the Integral ASIE Model used with technology, was especially effective in materialization of abstract concepts, learning information more easily, making the lessons more enjoyable and eager for the preservice teachers constituting the experimental group.

Suggestions

Suggestions developed in line with the results obtained in line with the findings from the study are presented under three headings as suggestions for practitioners, suggestions for designers and suggestions for researchers.

Suggestions for researchers

- The results obtained by applying it in different teaching levels can be compared.
- The research is limited to the subject of Genetics within the course of Genetics and Biotechnology. Researchers can conduct a different research on a different topic or a whole course.

- The research can be carried out with a larger study group and the results can be compared.
- In this study, the effects of teaching designed with the Integral ASIE model on academic achievement and the opinions of preservice teachers about the model and implementation process were examined. The effect of the model on permanence, the effect on the attitude or motivation to the related course may be investigated.
- If there are internet-based materials to be used for teaching designed with the Integral ASIE model, external internet can be supplied by considering that there may be problems from time to time due to the lack of infrastructure during the use of these materials.
- If the model is to be applied by practitioners who have no previous experience with this model, it would be appropriate for them to receive opinions from the relevant experts in order to understand the features of the model well and on the process related to the implementation and design process.
- It was determined that preservice teachers experienced reluctance due to the video recording used during the research for the purpose of transparency. Therefore, practitioners may not use video recording.
- It was observed that the interim evaluations used prevented fear of exams in preservice teachers. Thus, it is believed that with the interim evaluations used in the research or with similar features can help to overcome the fear of exams of students.

Suggestions for designers

- With the Integral ASIE model, teaching can be designed for different courses and subjects.
- The research was conducted with prospective teachers studying at the undergraduate level. Instruction can be designed for different levels of education.
- Different teaching methods and techniques can be used in the designed instruction.

REFERENCES

Akkoyunlu, B., Altun, A., & Soylu, M. Y. (2008). *Öğretim tasarımı.* (1. Baskı), Ankara: Maya Akademi Yayın Dağıtım.

Andrews, D. H., & Goodson, L. A. (1980). A comparative analysis of models of instructional design. *Journal of Instructional Development*, *3*(4), 161–182.

Ariefiani, Z., Kustono, D., & Pathmantara, S. (2016). Module development with project-based learning approach and ASSURE development model. In *AIP Conference Proceedings* (C. 1778). https://doi.org/10.1063/1.4965770, Erişim tarihi: 11/03/2017.

Asuncion, R. J. R. (2016). Effects of ADDIE model on the performance of B.E.E.D. sophomore students in the project-based multimedia learning environment. *International Journal of Multidisciplinary Approach and Studies*, *3*(3), 119–129.

Başak, M. H., & Ayvacı, H. Ş. (2017). Teknoloji entegrasyonunun eğitim alanında uygulanmasına yönelik bir karşılaştırma: Türkiye - Güney Kore örneği. *Eğitim ve Bilim*, *42*(190), 465–492.

Burke, W., & Emery, J. (2002). Genetics education for primary-care providers. *Nature Reviews Genetics*, *3*(7), 561–566.

Büyüköztürk, Ş. (2011). *Veri analizi el kitabı.* (15. Baskı), Ankara: Pegem Yayıncılık.

Cheung, L. (2016). Using the ADDIE model of ınstructional design to teach chest radiograph interpretation. *Journal of Biomedical Education*, *2016*, 1–6.

Cresswell, J. W. (2008). *Educational research: planning, conducting and evaluating quantitative and qualitative research*. New Jersey: Pearson.

Creswell, J. W., & Clark, P. V. L. (2007). Understanding mixed methods research, (Chapter 1). In *Designing and Conducting Mixed Methods Research* (2nd Edition). Los Angeles.

Çepni, S. (2010). *Araştırma ve proje çalışmalarına giriş.* (5. Baskı), Trabzon: Celepler Matbaacılık.

Çetin, Y. (2019). İnsan ve çevre ünitesinin öğretiminde kullanılan integral ASIE modelinin öğrenci başarısına etkisi ve modele yönelik öğrenci görüşleri. *YYÜ Eğitim Fakültesi Dergisi (YYU Journal of Education Faculty), 16*(1), 985–1009.

Dehoff, M. E. (2010). Genetics education in the laboratory: addressing students' misconceptions through instruction and activities. *Association for University Regional Campuses of Ohio Journal*, *16*, 63–89.

Demir, A., & Sezek, F. (2009). İlköğretim sekizinci sınıf fen ve teknoloji dersi genetik ünitesindeki kavram yanılgılarının giderilmesinde grafik materyallerin etkisi. *Uludağ Üniversitesi Eğitim Fakültesi Dergisi*, *XXII*(2), 573–587.

Dewaters, J., & Powers, S. E. (2006). Improving science and energy literacy through project-based K-12 outreach efforts that use energy and environmental themes. *Proceedings of the 113th Annual ASEE Conference and Exposition*, Chicago, IL.

Duda, H. J. (2016). Analysis of genetic misconceptions student biology education at STKIP Persada Khatulistiwa Sintang. In *International Conference on Education* (pp. 369–375).

El-Hani, C. N. (2014). Mendel in genetics teaching: Some Contributions from history of science and articles for teachers. *Science & Education*, *24*, 173–204.

Erdoğan, A., Özsevgeç, L. C., & Özsevgeç, T. (2014). Öğretmen adaylarının genetik okuryazarlık düzeyleri üzerine bir çalışma. *Necatibey Eğitim Fakültesi Elektronik Fen ve Matematik Eğitimi Dergisi*, *8*(2), 23–38.

Farokhi, M., Vahid, M., Nilashi, M., & Branch, L. (2016). Journal of soft computing and decision support systems a multi-criteria recommender system for tourism using fuzzy approach. *Journal of Soft Computing and Decision Support Systems*, *3*(4), 19–29.

Fer, S. (2011). *Öğretim tasarımı.* (2. Baskı), Ankara: Anı Yayıncılık.

Germaine, R., Richards, J., Koeller, M., & Scubert-Irastorza, C. (2016). Purposeful use of 21st century skills in higher education. *Journal of Research in Innovative Teaching*, *9*(1), 2–17.

Günüç, S., Odabaşı, H. F., & Kuzu, A. (2013). 21. yüzyıl öğrenci özelliklerinin öğretmen adayları tarafından tanımlanması: Bir twitter uygulaması. *Eğitimde Kuram ve Uygulama*, *9*(4), 436–455.

Hadi, S. P. I., Kuntjoro, T., Sumarni, S., Anvar, M. C., Widyawati, M. N., & Pujiastuti, R. S. E. (2017). The development of e-partograph module as a learning platform for midwifery students : The ADDIE model. *Belitung Nursing Journal*, *3*(2), 148–156.

Jacovou-Johnson, S. (2014). Instructional design : In the driver's seat. *Training & Development*, (October), 14–16.

Kalaycı, Ş. (2010). *SPSS uygulamalı çok değişkenli istatistik teknikleri*. (5. Baskı), Ankara: Asil Yayın Dağıtım Ltd. Şti.

Kang, M., Heo, H., Jo, I.-H., Shin, J., & Seo, J. (2010). Developing an educational performance indicator for new millennium learners. *Journal of Research on Technology in Education*, *43*(2), 157–170.

Karagöz, M., & Çakır, M. (2011). Problem solving in genetics: Conceptual and procedural difficulties. *Educational Sciences: Theory & Practice*, *11*(3), 1668–1674.

Kemp, J. E., Morrison, G. R., Ross, S. M., & Kalman H. K. (2007). *Designing effective instruction* (5th Edition). Hoboken, NJ: John Wiley & Sons Inc.

Kim, D., & Downey, S. (2016). Examining the use of the ASSURE model by K–12 teachers. *Computers in the Schools*, *33*(3), 153–168.

Marshall, M. N. (1996). Sampling for qualitative research. *Family Practice Oxford University Press*, *13*(6), 522-526.

MEB (2013). *İlköğretim kurumları fen bilimleri dersi (3,4,5,6,7 ve 8. Sınıflar) öğretim programı*. *Talim ve Terbiye Kurulu Başkanlığı*. Ankara.

MEB (2017). *Fen bilimleri dersi öğretim programı* (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar), Ankara.

MEB (2018). *Fen bilimleri dersi öğretim programı* (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar), Ankara.

Miles, M. B., & Huberman, A. M. (1994). *Qualitative data analysis: An expanded sourcebook* (2nd ed.). Sage Publications, Inc.

Miles, M. B., Huberman, A. M., & Saldana, J. (2014). *Qualitative data analysis: A methods sourcebook*. European Journal of Science Education. Los Angeles: Sage Puplication, Thousand Oaks.

Nissim, Y., Weissblueth, E., Scott-Webber, L., & Amar, S. (2016). The effect of a stimulating learning environment on pre-service teachers' motivation and 21st century skills. *Journal of Education and Learning*, *5*(3), 29–39.

Paz De Jesus, M., & Mitchel, M. (2016). Today's nurses need genetics education. *Nursing*, *46*(10), 68.

Pekel, F. O., & Hasenekoğlu, İ. (2015). Dynamising conceptual change approach to teach some genetics concepts. *E-International Journal of Educational Research*, *6*(2), 51–68.

Savenye, W. C., Olina, Z., & Niemczyk, M. (2001). So You are going to be an online writing instructor: Issues in designing, developing, and delivering an online course. *Computers and Composition*, *18*, 371–385.

Smith, M. K., Wood, W. B., & Knight, J. K. (2008). The genetics concept assessment: A new concept iventory for gauging student understanding of genetics. *CBE Life Sciences Education*, *7*, 422–430.

Shapiro, S. S., & Wilk, M. B. (1965). An analysis of variance test for normality (Complete samples). *Biometrika, 52*(3/4), 591–611.

Şimşek, A. (2009). *Öğretim tasarımı* (1. Baskı). Ankara: Nobel Yayın Dağıtım.

Trilling, B., & Fadel, C. (2009). *21st century skills* (1. Edition). United States of America: John Wiley & Sons Inc.

Tsui, C. Y., & Treagust, D. F. (2003). Genetics reasoning with multiple external representations. *Research in Science Education*, *33*, 111–35.

URL-1. Öğrenme Stilleri Testi. 02.02.2017 tarihinde http://mebk12.meb.gov.tr/meb_iysdosyalar/35/08/965483/-dosyalar/2013 01/15095651_ogrenmestilleritesti.doc adresinden alınmıştır.

URL-2. Öğrenme Stilleri ve Öğrenme Stillerine Göre Ders Çalışma 04.02.2017 tarihinde http://dereagziortaokulu.meb.k12.tr/icerikler/2016-2017-ogrenme-stilleri-ve-ogrenme-stillerine-gore-ders-calisma-semineri_2763368.html adresinden alınmıştır.

Utama, A. A. G. S. (2016). The usage of e-learning model to optimize learning system in higher education by using Dick and Carey design approach. *Journal of Information Systems Engineering and Business Intelligence*, *2*(1), 192–196.

Vickova, J., Kubiatko, M., & Usak, M. (2016). Czech high school students' misconceptions about basic genetic concepts: Preliminary results. *Journal of Baltic Science Education*, *15*(6), 738–746.

Yıldırım, A., & Şimşek, H. (2011). *Sosyal bilimlerde nitel araştırma yöntemleri* (8. Baskı). Ankara: Sözkesen Matbaacılık.

Zain, I. M. (2015a). An Integral ASIE ID Model: The 21st century instructional design model for teachers. In *8th International Conference on Teaching, Education and Learning (ICTEL)*. Kuala Lumpur/Malaysia.

Zain, I. M. (2015b). An Integral ASIE Instructional Design Model: An integrated approach in instructional planning for the 21st century learning & teaching environment. *Journal of Education*, *1*(1), 41–49.

Zain, I., Muniandy, B., & Hashim, W. (2016). An Integral ASIE ID Model : The 21st century instructional design model for teachers. *Universal Journal of Educational Research*, *4*(3), 547–554.