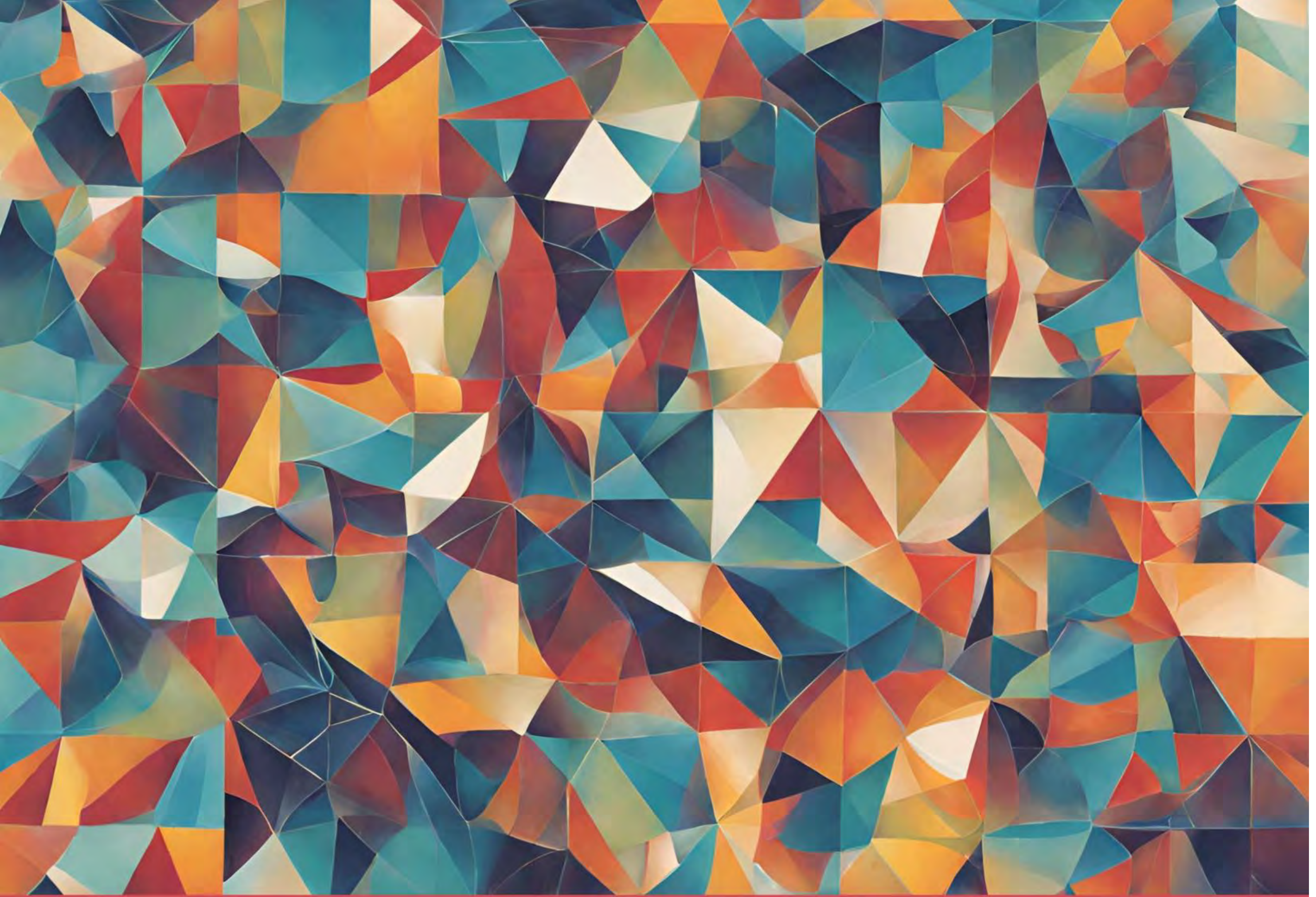

COGNITIVE STYLES AND EYE TRACKING

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Preface

Addressing cognitive style and eye tracking together, this book offers a new perspective on cognitive psychology and human behavior; at the same time, it defines a new application version for the Group Embedded Figures Test developed by Witkin and colleagues and applied in print, taking advantage of 21st century technological developments. This book not only contributes to the understanding of the concept of cognitive style but is also intended as a resource for readers who wish to follow the latest developments in this concept.

The Group Embedded Figures Test, adapted to the computer environment, makes the analysis of cognitive style more accessible and brings with it the possibility of obtaining more detailed data in the analysis process. Test takers can now examine their cognitive styles in more detail using this new adapted form instead of a paper-and-pencil test. At the same time, eye-tracking technology combined with test administration allows us to observe participants' mental processes simultaneously. The developments presented in this study represent an important step forward in cognitive style and eye-tracking research.

The book explains how computerized tests of cognitive style and eye-tracking technology are used and how the combination of these two tools contributes to cognitive psychology, thus introducing the reader to the importance of this innovative approach. This book offers an introduction to cognitive style analysis and eye-tracking research, exploring their applications and the interpretation of results. It also presents the results of two different studies in this area.

Summaries of these studies are presented below;

> *" The purpose of the study discussed in the first section is to develop a computer version of the Group Embedded Figures Test (GEFT) and to investigate the equivalence between the computer version and the paper-and-pencil version of the GEFT. The study group consists of 125 pre-service elementary teachers enrolled in the Computer I and II courses at the Department of Elementary Education of a university in Central Anatolian and Western Black Sea region.*
>
> *The computer version of the GEFT was developed based on the computer-based testing approach, taking into account all the features of the paper-and-pencil version of the GEFT. Equivalence between the two versions was evaluated by analyzing mean score, standard deviation, test-retest reliability, and correlation differences. As a result, a computer version of the GEFT was created that is equivalent to the paper-and-pencil version and has high usability."*
>
> *" Technological advancements have far-reaching effects across all scientific fields. In education, for example, teaching methods are increasingly incorporating computer software. Consequently, evaluation tests are now more easily transferred to and administered in a digital environment. Psychometric tests, which assess cognitive characteristics, are one such example of these evaluations.*
>
> *The purpose of the study is to identify the regions of focus of field-dependent and field-independent individuals in their responses to the computer version of the Group Embedded Figures Test (GEFT) using an eye-tracking device and software, and to model them according to individuals' cognitive styles. The computerized (GEFT-C) was utilized for this purpose.*

This study falls within the descriptive research category as it was conducted through the computer version of GEFT, which demonstrates eye movements in individuals with domain-dependent and domain-independent cognitive styles and models their behavior. For data collection, this study utilized the computer-based version of the GEFT, developed by Witkin et al. (1977) and later adapted to Turkish culture by Bahar (2003). This tool instructs participants to locate and label basic figures within more complex ones.

A total of 20 preservice elementary teachers, studying at the Department of Elementary Education of a university in the Western Black Sea region, participated in the study discussed in the second part. The study took place at the end of the spring semester in 2017-2018. GEFT paper-and-pencil application was previously used to determine the cognitive styles of the participants. The group comprised of 10 field-dependent preservice teachers, including 5 females and 5 males, and 10 field-independent preservice teachers, also with 5 females and 5 males. The preservice teachers' focus on specific parts of the computer screen was analyzed using an eye-tracking device during the GEFT-C questionnaire. The results were then presented according to a predetermined model."

We would like to thank all the authors and supporters who contributed to the preparation of this book. This publication offers a fresh perspective and advances research on cognitive styles and eye tracking technology by presenting the latest information. Our aim is to open new avenues for exploration in this field.

Best regards,

EDITORS

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October, 2023

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CHAPTER 1

Computerized Version of the "Group Embedded Figures Test" Used in Determining Cognitive Styles: A Case Study[1]

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Introduction

The concept of cognitive style is generally defined as a way of approaching problems, a way of problem solving, thinking, perceiving and remembering. Cognitive style determines individual differences in the way information from the outside world is received, processed, stored and used. It can be effective in all cognitive processes such as perception, memory, thinking and problem solving. Many cognitive styles have been proposed with very different theoretical approaches and using different techniques. One of them is the field dependence and field independence cognitive styles proposed by Witkin et al (1977).

Witkin and Goodenough (1981) state that individuals with field dependent cognitive style rely on external frame of reference, while individuals with field independent cognitive style rely on internal frame of reference. The concept of field dependence and field independence is defined as the tendency of the individual to be more or less influenced by external perceptual bases in cognitive and social activities. Field independent individuals are more successful than field dependent individuals in "cognitive restructuring" processes, which are defined as identifying the elements of the field by analyzing its complex structure, finding and extracting a specific

[1] This study was supported by Bolu Abant Izzet Baysal University BAP unit (Project No: BAP - 2017.02.04.1230).

element from a complex whole, distinguishing between the elements of the field and, as a result, organizing the field differently according to the requirements of the task.

Field independent individuals are defined as analytical, competitive, individualistic, task-oriented, highly intrinsically motivated, spatially oriented, detail-oriented and visually oriented (Fritz, 1994; Reiff, 1996; as cited in Altun, 2003). Field dependent individuals, on the other hand, are defined as individuals who are fond of group work, sensitive to social interaction, seek extrinsic motivation, are non-verbal expressive, take what is offered to them and are passive (Liu & Reed, 1994; Lyons-Lawrence, 1994; Riding & Cheema, 1991; as cited in Altun, 2003).

In the learning process, it is pointed out that the cognitive styles of cognitively different individuals cannot be ignored and that learning environments may differ according to individuals' preferences. It has been revealed that field dependent individuals may prefer computer environments where information is well compiled and presented with plenty of examples; on the other hand, it may be effective for field independent individuals to create their own learning processes with active participation in accessing information (Altun, 2003). The most basic idea in the educational environment is that there are individual differences among students and that these differences should be used in the creation and organization of educational environments.

The Group Embedded Figures Test (GEFT) (Witkin et al, 1971; Witkin et al, 1977), which is based on finding simple figures embedded in complex figures, is used to determine the cognitive styles of individuals. As a result of the Group Embedded Figures Test (GEFT), individuals' cognitive styles can be determined as “Field Dependent” or “Field Independent”.

Following the introduction of the computer revolution into schools, developments in computer technology have led to the emergence of computer-assisted testing. Thanks to computer-assisted tests, test results can be obtained and evaluations can be made in the fastest way possible. It is stated that such tests have a more concrete structure than paper-and-pencil tests. In addition, once the infrastructure is established, it can be easily reorganized and used in different fields (İmamoğlu, 2007).

Computer Based Tests

Computer applications in education have increased considerably in recent years. In fact, computers are used as an important educational tool in many schools. Computer technologies facilitate researchers and teachers in areas such as computer-based instruction, assessment, file keeping and school management. One of the most important areas of computer use in education is computer-based assessments.

Computer-based assessments create an environment that allows students to take exams, teachers to structure exam questions and teachers to communicate exam results. Nowadays, with the widespread use of developing technology in educational institutions and increased interaction of students with technology, computer-based tests have become applicable. Flexibility in terms of time can also be provided with assessments in which the processes of designing, implementing and determining the results of exams are carried out in a computer environment via the internet (Bayazıt, 2007; Sampson, 2000). It can be said that tests used within the scope of computer-based assessment in education have become widespread. It can be predicted that computer-based tests, which have started to be preferred as an alternative to traditional paper-and-pencil tests and have become widespread in exams held throughout the country (e-YDS, e-ALES, electronic driving license exam, etc.), will be used in the entire assessment process in the future. In this context, it becomes important to prefer computer-based assessments in the assessment process by considering their advantages and disadvantages.

Advantages and Disadvantages of the Computer-Based Assessment Approach

The computer-based assessment approach has several advantages and disadvantages compared to paper-and-pencil tests. Advantages of computer-based assessment approach (Bayazıt, 2007; Luecht, 2005; Sampson, 2000; Şengel, 2009; Thompson, Thurlow, Quenemoen, & Lehr, 2002; Titus, Martin, & Beichner, 1998; Yağcı, Ekiz, & Gelbal, 2015):

- The test can be administered at any time.
- It is possible to add multimedia (video, image, audio, etc.).
- There is the possibility to create a question pool and easily update the questions.
- It enables statistical results to be obtained quickly and accurately.
- It allows automatic retrieval of the exam evaluation.
- Allows easy storage of individual reports and exam data.
- Documents such as test papers and optical forms are not required.
- Provides faster feedback to students.
- It allows the student to see their mistakes at the end of the exam and learn the correct information.
- Objective answers allow for a more reliable assessment.

The computer-based assessment approach has many advantages for students and teachers at every stage, from the exam preparation process to the process of evaluating the results and giving feedback. In this context, it is inevitable that it will be preferred and become more widespread. On the other hand, there are also disadvantages of computer-based assessment approach (Dalziel, 2000; Hollenbeck, Tindal, & Almond, 1999; İmamoğlu, 2007; Ommerborn & Schuemer, 2002; Şengel, 2009; Thompson, Thurlow, Quenemoen, & Lehr, 2002; Yağcı, Ekiz, & Gelbal, 2015):

- There may be hardware or access time issues.
- Computer usage skills are required.
- There may be problems with computer hardware and software.
- There may be a security problem.
- A system error may occur.
- Students can use the resources during the exam process.
- The student may accidentally end the exam before the end of the exam.
- Economically, it can be costly compared to paper-and-pencil testing when software development is required.
- There may be problems such as students not being able to return to difficult questions that they cannot answer or not moving on to the next question after answering.
- Activities such as taking notes, underlining, calculating, using formulas on a computer screen can be difficult.
- Prolonged reading on a computer screen can strain the eyes.

Considering the advantages and disadvantages of the computer-based assessment approach, it can be said that the disadvantageous points can be eliminated with the developing technology and the advantageous points will increase. If the disadvantages for students and teachers are eliminated in the process, it becomes inevitable that computer-based assessments will be widely used in education.

Computer-Based Measurement and Usability

Computerized systems are expected to be usable to provide an appropriate user experience for their target audience. Usability is defined as the ability of the user to do what he/she wants to do in a system in the way he/she expects it to be done and not to experience obstacles or hesitations in this process (Rubin & Chisnell, 2008). To investigate the usability of the developed systems, usability tests should be conducted to enable real users to use the designed system in an authentic environment, to examine their performance in this process and to reveal possible problems and deficiencies. However, when the studies are examined, it is seen that usability tests are ignored in the development processes of computer-based measurement tools.

Rubin (1994) states the basic elements of usability tests as follows:

- Developing test objectives or research questions instead of hypotheses,
- Selection of a representative sample of potential end users,
- Provision of an actual working environment,
- Observing users using or criticizing the product,
- Collecting qualitative and quantitative data on user experience,
- Making suggestions for improving the design,

As can be seen from the basic elements, usability testing is based on a potential real user using the designed system and providing feedback on the difficulties they experience while performing the tasks assigned to them. In addition, eye tracking devices are used to record data such as how long and where on the computer screen the user looks and for how long. In the analysis process, the position of the components to be used in the task can be decided by monitoring the task given to the user and the user's movements on the screen. In addition, evaluation data from the user will also help to make the design user-friendly.

Eye

Human visual perception generally consists of three parts. These are fovea, parafovea and periphery. The fovea is the central area of the retina. Parafovea defines the region surrounding the fovea. Peripheral refers to the area outside the parafovea. Clarity is highest in the fovea, decreases in the parafovea and is even weaker in the periphery (Lai et al., 2013). People frequently move their eyes in the foveal region, where visual resolution is highest, to see events clearly and to locate objects of interest (Wade & Tatler, 2011, p.18). Researchers working on eye movement (Duchowski, 2007; Liversedge, Gilchrist, & Everling, 2011; Underwood & Radach, 1998) have gone on to define different types of eye movement. Some of these are saccades and smooth pursuits that keep the fovea on a visual target in the environment; others are fixations that keep the eye in balance during head movement. When reading, looking at a scene or searching for an object, eye movements called saccade are continuous. Between saccade, our eyes experience a moment of fixation lasting approximately 200-300 ms. Saccade are rapid movements of the eye, reaching speeds as high as 500 degrees per second (Rayner, 1998). According to Gilchrist (2011), saccades are rapid ballistic eye movements. After each saccade, the eye enters a period of fixation where it remains relatively still and collects important visual information. It is during this stationary phase that the eye gathers useful visual data. Saccades are essential for looking at regions of interest because visual acuity decreases as the gaze direction changes.

The temporal and spatial structure of the visual system's input is defined by saccadic sampling and the rapid decline in visual ability. During every fixation, peripheral vision is utilised to identify the subsequent fixation location. In scenarios with multiple potential targets, determining the target for the subsequent saccade necessitates interplay between the visual attributes of the surrounding areas and the target of the observer.

According to Castelhano and Rayner (2008), the eyes move every 250-350 ms when reading or searching a visual sequence for a target or simply looking at a new scene.

These eye movements move the fovea (the high-resolution portion of the retina that encompasses the middle 2 degrees of the visual field) to an area of interest for more detailed processing. Eye movements are necessary to process the details of the array due to sharpness limitations in the retina. The human ability to discriminate fine detail is markedly reduced in the parafovea outside the fovea (extending to about 5 degrees on either side of fixation) and in the periphery (everything beyond the parafovea).

During the actual eye movement (or saccade), vision is suppressed and new information is acquired only during fixation (when the eye is still at approximately 250-350 ms). Although the entire visual sequence can be processed in a single fixation and the essence of the scene can be rapidly acquired in a single fixation, information outside of foveal vision cannot be fully processed when the eyes are not moving (Rayner, 1998).

Usability

It can be defined as the easy and effective use of the tasks specified in any application by the users determined as the target audience by providing the necessary training and technical support (Acartürk & Çağıltay, 2006).

There are 3 different dimensions that are considered as the main criteria for usability. These are effectiveness, efficiency and satisfaction. In other words, usability is defined as the degree to which a product can be used effectively, efficiently and satisfactorily by specific users for specific purposes within a specific usage framework. While the effective use of a product is evaluated by the users' achievement of the accuracy and completeness of certain objectives, its efficient use is evaluated by measuring the resources spent for the accuracy and completeness of the objectives achieved. In this direction, the definitions of satisfaction, user, task, purpose and usability testing, which are the basic components of usability studies, are as follows (Human-Computer Interaction Research and Application Laboratory - IBE, 2018a):

- Satisfaction: Freedom from difficulties of use and positive attitudes towards the use of the product,
- User: The person who interacts with the interface,

- Task: Activities necessary to achieve the goal,
- Purpose/Objective Output: The activity that the user wants to achieve.

Usability testing is defined as making the interface, whose usability is to be evaluated, perform the specified tasks in the specified target audience and obtaining efficiency, effectiveness and satisfaction values from the user in this process. After the users are identified, they are asked to perform the tasks of accessing the information that is most used in the interface to be tested and/or that is important to access although it is used less frequently.

Steps Applied in Usability Study

After determining the interface for the usability study,

- Tools to be used during this study (e.g., questionnaires),
- Target user group,
- The tasks to be performed by target users are identified.

Once these components are identified, the next step is the testing phase. If the tools to be used include a questionnaire to measure the user's attitude or knowledge before using the interface, the user is given this questionnaire to fill in before starting the test. Following this, the user is given tasks one by one. For each task, information about whether the user succeeded or failed, the number of errors made and the duration of the task is kept. During the testing phase, the user is asked to think aloud, so that the user can find out where he/she has problems with the interface and what he/she thinks about the interface. During the test phase, the user's movements and utterances are recorded by the tester. At the end of the test, a satisfaction survey is given to find out the user's satisfaction with the interface. In addition to the usability methods mentioned above, eye tracking devices can also be used while performing these tests. In this way, concrete statistical data is obtained about both the interface design and the user's orientation while using the page. All data collected after the test is evaluated with analysis programs (İBE, 2018a).

Eye Tracking Method in Availability

Eye tracking in usability testing helps software designers to evaluate scene usability (Tonbuloğlu, 2010*). The eye-tracking apparatus supplies data on users' gaze location, frequency, and duration, as well as the concentration of their current and prior attention, and their goals and cognitive condition. T*his data, which can be obtained both numerically and visually from the eye tracking device, provides information about how users interact with the interface and aims to make interfaces more efficient and effective with this information (İBE-2018b).

The eye-tracking method primarily emerged based on the aforementioned characteristics of eye movements. Additionally, Just and Carpenter's (1980) "eye-mind" hypothesis proposes that eye movements offer a dynamic record of attention allocation. Eye tracking has been applied extensively to psychology research for many years with success (Lai et al., 2013). Most of the studies conducted with eye tracking involve information processing such as reading, scene perception, visual search, music reading and writing.

Examples include the work of Radach and Kennedy (2004) and Rayner (1998, 2009). On the other hand, there are also studies that include the application of eye tracking techniques to study human-computer interactions (Goldberg & Helfman, 2011; Jacob & Karn, 2003). Researchers in the field of education have made efforts to investigate and adapt different research methods developed in other academic fields to see and analyze the student's learning process from different perspectives (Anderson, 2007).

Eye tracking is a technique that has gained significant attention from educators, particularly psychologists who study basic cognitive processes involved in reading and other forms of information processing (Rayner, 1998). This method's capability to recode online cognitive activities makes it a highly promising tool for monitoring the cognitive learning process. Eye movement studies into learning will provide educators with a deeper comprehension of the capabilities and applications of eye-tracking technology (Lai et al., 2013).

Advantages and Disadvantages of Eye Tracking Method

Eye tracking has numerous advantages as an assessment method; however, the analysis of data obtained from the technique can be laborious and prone to potential mistakes and misinterpretations. Goldberg and Helfman (2011) outline the benefits of using eye tracking methods, as follows:

Access to Pre-Attentional Behaviour: Eye movements can appear highly stochastic when directly observed but are controlled by higher-level cognitive processes. Individuals are not aware of lower-level eye fixations; they are typically cognizant of higher-level control strategies. Recording fixation flow while performing tasks provides insight into pre-attentional behaviour, which can give statistically meaningful strategic information when assessed under various conditions.

Understanding sequential strategies: Traditional evaluation studies often rely on response time measurements, but using sequences of anchored areas can provide insight into the strategy used between task emergence and completion. It is valuable to understand the differences in these sequential strategies across various design options in order to develop designs that maximize efficiency.

Error analysis: By comparing sequential strategies between error and non-error trials, designers can obtain diagnostic information that response time methods often miss. Examining the landing locations of individual fixations can reveal errors occurring in a fraction of a second.

- On the other hand, eye tracking methods should be used with caution. Problematic issues in eye tracking are as follows:

Identifying Fixations: Gaze samples, usually gathered at a rate of 60-120 Hz, undergo algorithmic filtering for fixations of around 3 Hz. Various temporal and/or spatial dispersion algorithms, not commonly reported, exist. It is yet to be fully comprehended how the use of different dispersion algorithms could impact the findings of the fixation analysis.

Specifying areas of interest: To generate metrics for eye tracking performance, areas of interest (AOIs) can be identified within an imaged scene or image after collecting the dataset. Eye tracking software can quickly generate initial fixation duration metrics, including AOI, AOI-order, AOI-viewing percentage and others. Nevertheless, identifying these AOIs is not always straightforward.

Defining metrics: The identification of metrics from eye tracking data is generally achievable, but the selection of appropriate metrics is contingent on the mission questions. Numerous resources are accessible that illustrate and contrast prospective metrics based on factors like efficiency and effectiveness.

Gaze localization error: Eyetracker manufacturers aim for accuracy rates of 0.5 degrees or less; however, several factors can cause inaccuracies in gaze location. These include inadequate calibration, distraction, and variations in retinal acuity between individuals. To minimize errors, a location error of 1 cm is frequently used as a reference point for eye tracking on computer screens viewed from a distance of 50 cm.

Scanpath interruptions: Scan path interruptions can occur when an observer blinks or looks away from the screen, causing the sequence of fixations recorded by the eye tracking device to be disrupted. As eye tracking software generally associates the last recorded fixation with the next available one, these interruptions can result in artificially long saccades. To address these issues, improved implementation guidelines are necessary (Goldberg & Helfman, 2011).

A usability study was conducted using an eye tracking device to develop the computer-based measurement tool within the study's scope. The design was enhanced based on the feedback received.

Test Equivalence Studies

Pellegrino, Hunt, Abate and Farr (1987), in their research on the measurement of spatial reasoning ability, stated that stationary and moving objects can be shown to individuals via computer and variables such as the response time of individuals to questions can also be measured. The researchers adapted a test battery consisting of 10 tests to the computer environment and applied it on 170 individuals. As a result, the reliability coefficients of the subtests measuring reasoning power on static images were found between .67 and .91, the reliability coefficients of the subtests measuring reasoning power on moving images were found between .63 and .99 and the reliability coefficient for only the path memory subtest was calculated as .50.

White and Helgeson (1994) examined the relationship between students' performances on paper and pencil and HyperCard forms in their study using HyperCard software to determine student achievement in chemistry course. The research was carried out with a cohort of 60 students, who were tasked with balancing chemical equations during the examination. During the study, exam performances were judged on precision, the number of attempted solutions, and difficulty level. Analyses revealed that the high performing students enhanced their grades significantly when using the HyperCard platform, compared to the traditional paper and pencil method. Ergün (2002) investigated the correlation between test scores acquired through paper-and-pencil assessments and computer-based evaluations whilst considering variables like computer familiarity and anxiety. The sample of the study involved 98 first-year undergraduate students. The findings revealed that the students' performance in the paper-and-pencil test was considerably better than their performance in the computerised version. The relationship between computer anxiety and performance on the computerized form of the test was found to be significant and the differences between the performances of the students divided into two groups as low and high anxiety levels in the paper-pencil and computerized forms of the test were compared. It was found that the difference between the performances of students with low computer anxiety in both forms of the test was significantly lower than the difference between the performances of students with high computer anxiety in both forms of the test. Correlation coefficients were calculated to examine the association between the duration of computer usage, computer course participation, computer skills, and performance on the computerized version of the test. Results indicated a significant relationship between the duration of computer usage and computer skills with performance on the computerized test.

Bayazıt (2007), in his study conducted on a group of 46 third-year university students, compared the test duration and individual achievement based on the results obtained from paper-pencil and computerized test forms. The study cohort underwent random assignment into two groups. One group completed the test in a computerized format, whereas the other group opted for the traditional paper-and-pencil version. The results indicate no significant difference between individual performances in both versions of the test. However, participants using the computerized format took significantly longer to complete the test. It has been suggested that the variance in time could be attributed to the individual's initial introduction to the computer-based version of the examination during the application process.

Maguire, Smith, Brallier and Palm (2009) conducted a study on 179 students to investigate whether there is a difference in achievement between paper-and-pencil and computerized forms of a test. Each participant took four different administrations of the “Accounting - Intermediate” course during the semester. Forty-three students completed all of the paper-and-pencil tests and 92 students completed all of the computerized tests. As a result of the study, it was determined that the scores obtained by the students from the computerized form were significantly higher than the scores obtained from the paper-and-pencil form.

In the "Programme for International Student Assessment (PISA) Computer-Based Assessment of Student Skills in Science" report (2010) commissioned by The Organisation for Economic Co-operation and Development (OECD), the study explored whether there existed a disparity in the average scores attained from the paper-pencil and computer-based versions of a science skills test for students. In the computerised version of the examination, students had the chance to navigate between questions, affording them the ability to answer whichever questions they choose in a similar fashion as the paper-and-pencil version. In the computerised version of the examination, students had the chance to navigate between questions, affording them the ability to answer whichever questions they choose in a similar fashion as the paper-and-pencil version. Furthermore, the questions for the computerised test were displayed interactively, utilising animation, video, and photographs. The 2006 PISA Trial Application was conducted in 13 countries and preliminary analyses were performed on data received from 12 of them. The research was conducted using students studying in Iceland, Denmark, and Korea. The results showed no significant difference in test scores between the paper-and-pencil and computerized forms among the students. Additionally, male students scored higher on computerized tests than their female counterparts. As no significant correlation was found between motivation, computer literacy, and enjoyment of computers with performance in the test, the high performance of males could not be attributed to these variables.

Aybek (2012) conducted a study using a general aptitude test in both paper-pencil and computer formats. The purpose of the study was to compare the psychometric properties of the tests and student performances, taking into account attitudes towards computers, computer familiarity, and gender. The students took the test in both paper-pencil and computer formats. The study group comprised 136 6th grade students, 73 of whom were male and 63 female. The general aptitude test comprised 60 items within verbal and numerical reasoning subtests. The study's findings concluded that the paper-pencil and computerized test formats were mostly equivalent. The computerized test scores did not show differences based on gender or computer familiarity but were dependent on the test-taker's attitude towards computers.

Importance and Purpose

Technological developments show their effects in every field of science. Especially in the field of education, computer software has started to be integrated into teaching methods with the developing technology and as a result of most of these studies, it has been observed that student achievement has increased (Sezer, 1989; Akoğlu, 2003; Akçay, Tüysüz, & Feyzioğlu, 2003). In addition to these effects of technology, paper-and-pencil tests, which are relatively difficult to evaluate, can be transferred to the computer environment and tests that can be evaluated more easily with the help of technology can be created. Some of these tests are psychometric tests that are used to determine the cognitive characteristics of the person.

The aim of this study was to create a computer-assisted version of the Group Embedded Figures Test (GEFT) that is at least as effective as the paper-and-pencil version in measuring cognitive styles. For this purpose, the items in the paper-and-pencil version of the Group Embedded Figures Test (GEFT) were transferred to the computer environment with the Macromedia Flash program and then a validity and reliability study was conducted for the computer version of the Group Embedded Figures Test (GEFT).

Method

Research Design

Since this study aims to compare the computer version of the GEFT with the paper-and-pencil version of the GEFT, it belongs to the correlational-relational research group of quantitative research methods.

Materials

Three tests were used in the study. The first of these tests is the "Perception of Computer Self-Efficacy Scale" (Aşkar & Umay, 2001), the second is the paper-and-pencil version of the GEFT (GEFT-P) and the third is the computer version of the GEFT developed for this study (GEFT-C).

Computer Self-Efficacy Perception Scale

In the study, the "Computer Self-Efficacy Perception Scale (CSPS)" developed by Aşkar and Umay (2001), which is a 5-point Likert-type scale consisting of 18 items, was used to determine the computer self-efficacy of preservice elementary teachers (See Table 1). Aşkar and Umay calculated the reliability coefficient of this scale as 0.71. Upon examination of previous studies, it has been determined that computer self-efficacy belief is a significant factor in computer usage (Aşkar and Umay 2001; Işıksal and Aşkar 2003). Consequently, it was confirmed that the participant preservice elementary teachers possessed equal computer proficiency levels.

Table 1. Sample Questions of the Computer Self-Efficacy Perception Scale

MATTERS	Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1. I believe I have a special talent for using computers.					
2. I have computer skills.					
3. I feel competent when I am at the computer.					
. . .					

Paper and Pencil Version of the Group Embedded Figures Test

The Group Embedded Figures Test (GEFT) is a test used to determine an individual's field dependent/field independent cognitive style. For this purpose, it measures the individual's ability to identify stimuli in complex domains and is one of the most widely used tests in this field. The GEFT, developed by Witkin and colleagues in 1971, consists of items that require individuals to locate and label simple figures among more complex figures. The first version of the test consists of three parts. The first part consists of 7 items and is applied for practice purposes. The second and third sections consist of 9 items each. The total number of items that individuals answered correctly in the second and third sections constituted their raw scores. Later, Witkin et al. (1977) developed a new version of the test. In this new version, as in the first test, students are expected to recognize and describe a simple shape Embedded in a complex frame. In the test, a sample question is first given and students are given one minute. At the end of this time, students are asked to examine the answer on the back of the page and compare it with their own answers. They are then asked to start the test. There are 20 complex shapes in the test and students have 20 minutes to complete the test. This version of the GEFT was translated and adapted into Turkish by Bahar (2003) and the internal consistency coefficient was found to be 0.80 (See Figure 1).

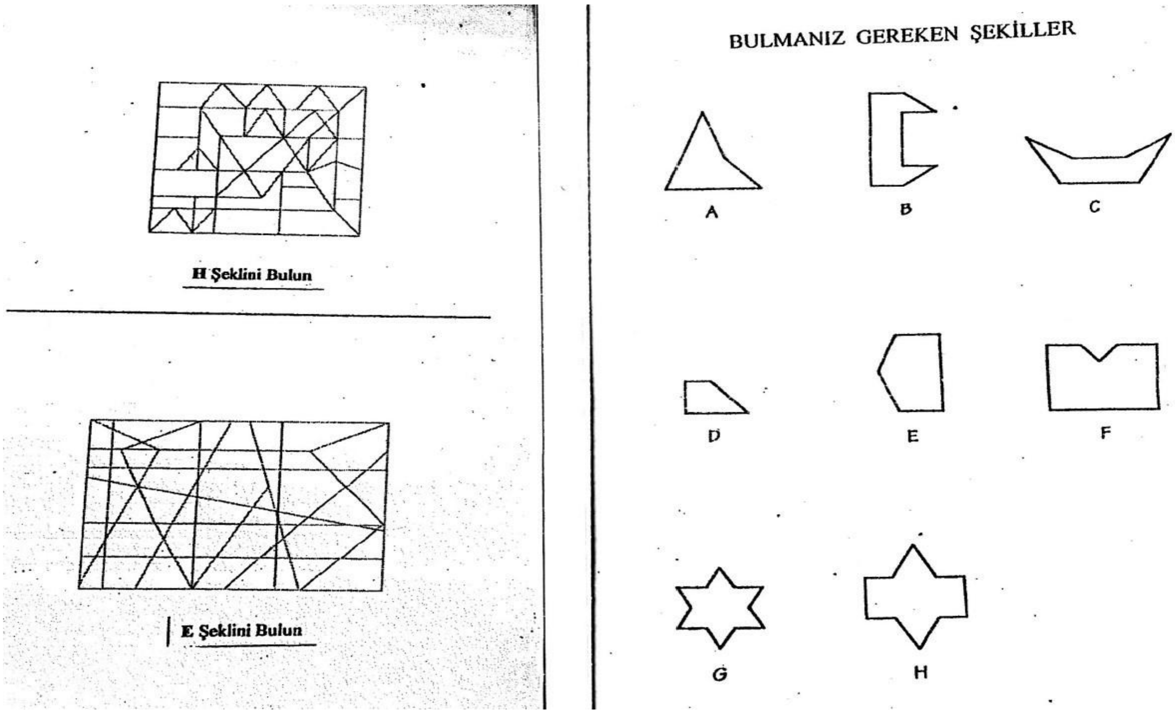


Figure 1. Two sample questions from the GEFT

Computer Version of the Group Embedded Figures Test

This study aimed to develop a computer version (GEFT-C) of the GEFT-P. While preparing the GEFT-C version, all questions were first scanned and transferred to the computer in order to adhere to the original paper-and-pencil version. Then, each scanned figure was redrawn with the Macromedia Flash program and the questions were prepared. Each question, which is a set of complex shapes, was programmed to allow the regions within each question to be clicked and painted. Thus, the desired shape was found by clicking on its equal in the complex structure.

The first version of the GEFT-C version was administered to five preservice elementary teachers and five instructors and their opinions about the test were obtained. In addition, two experts in measurement and evaluation were consulted for their opinions on the test.

After the initial design was prepared, a usability test was conducted with 10 participants randomly selected from among the potential users with the help of an eye tracking device. The 10 selected participants were asked to individually participate in the GEFT-C version and answer the test in the presence of a computer to which the eye tracking device was connected. This user experience was analyzed with the help of screen recordings and eye tracking data and the test was finalized by making improvements in the design with the feedback received from the users.

On the first page of the computer version of the test, a login screen was designed where the preservice teacher's ID number, gender and group were written. Then a “Start Test” button was placed (See Figure 2).

Figure 2. Test input screen

After the preservice teacher clicks on the “Start test” button, an animation about how to answer the questions appears and after watching this animation, the preservice teacher can replay the animation or go to the next page (See Figure 3).

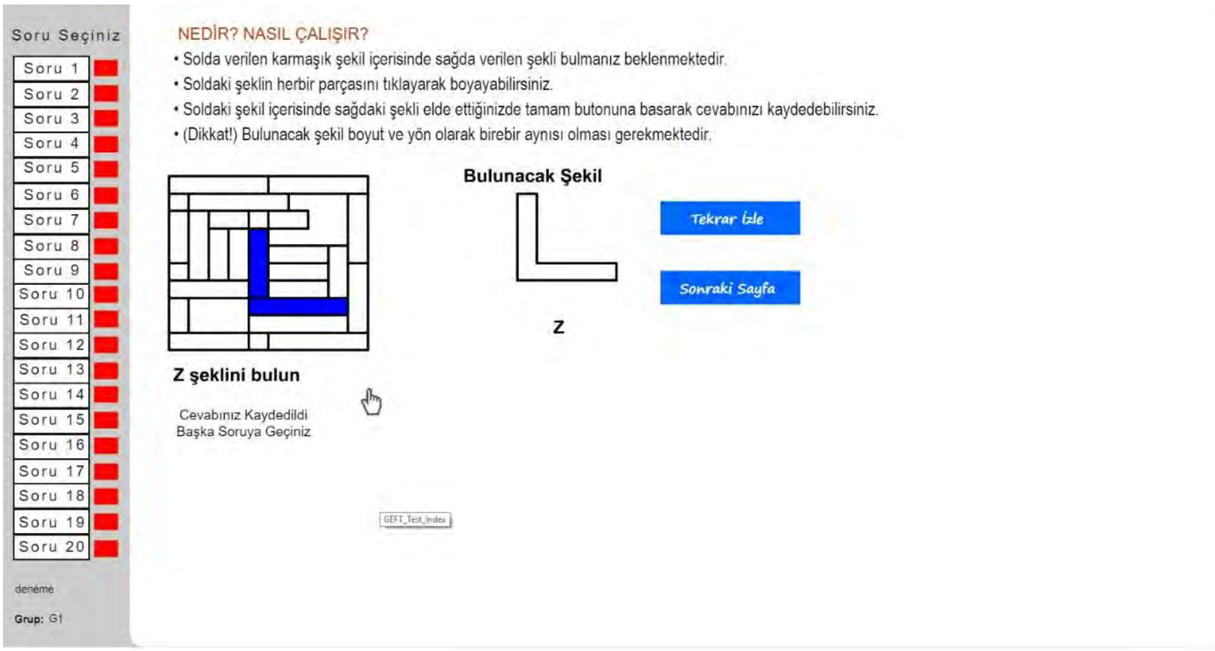


Figure 3. Information page on test usage

When the "Next Page" button is pressed, the preservice teacher is presented with another animation introducing the interface of GEFT-C. In this animation, the preservice teacher is informed that he/she can select the question number from the left column, that the "OK" button should be pressed after answering the question and that the answered questions can be checked from the bottom (See Figure 4).

Figure 4. Information page about question selection and confirmation

After selecting the question from the left column, the preservice teacher is presented with a complex shape and simple shapes to find within these complex shapes. In order to create the simple shape in the complex shape, the preservice teacher clicks on the small pieces and makes them colored blue. If the clicked shape piece is wrong, it can be clicked again to make it white again. If the blue pieces come together to form the desired shape, the "OK" button should be pressed. As soon as the "OK" button is pressed, the program detects that the answer to that question has been given and turns the red button next to the question number green. In this way, the preservice elementary teachers can see which questions he/she has answered. If the preservice teacher completes the test early and even if he/she has answered a question that he/she doubts, he/she can reopen the test and give a new answer. In this case, the program deletes the old answer and replaces it with the new one (See Figure 5-a, 5-b).

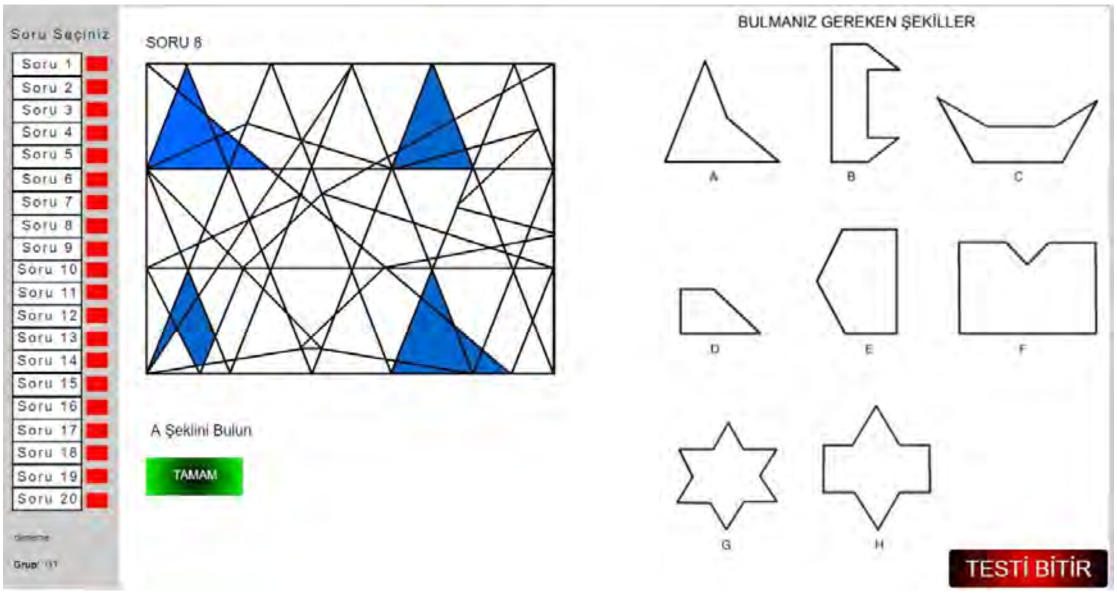


Figure 5-a. Example answer screen

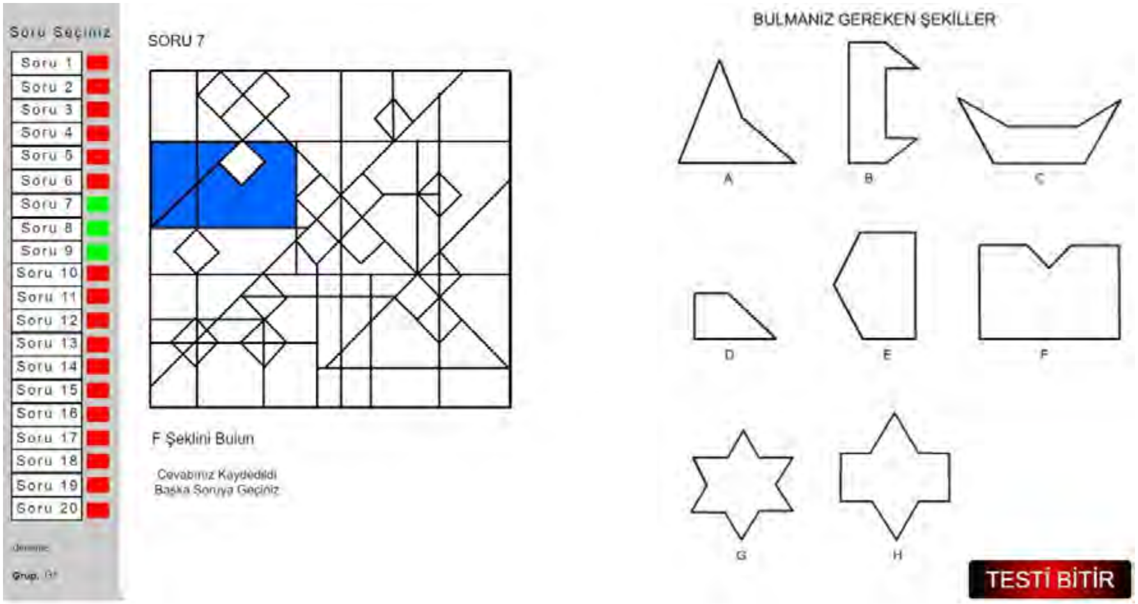


Figure 5-b. Example answer screen

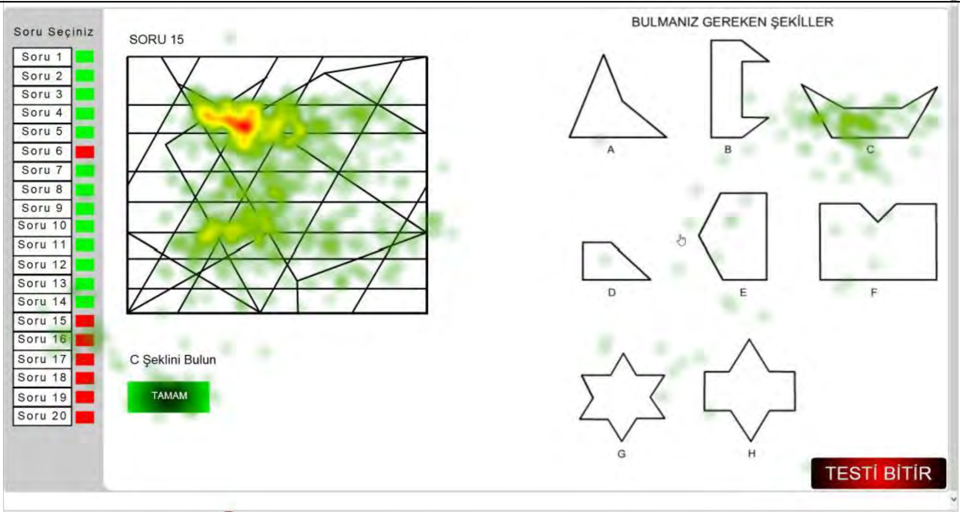
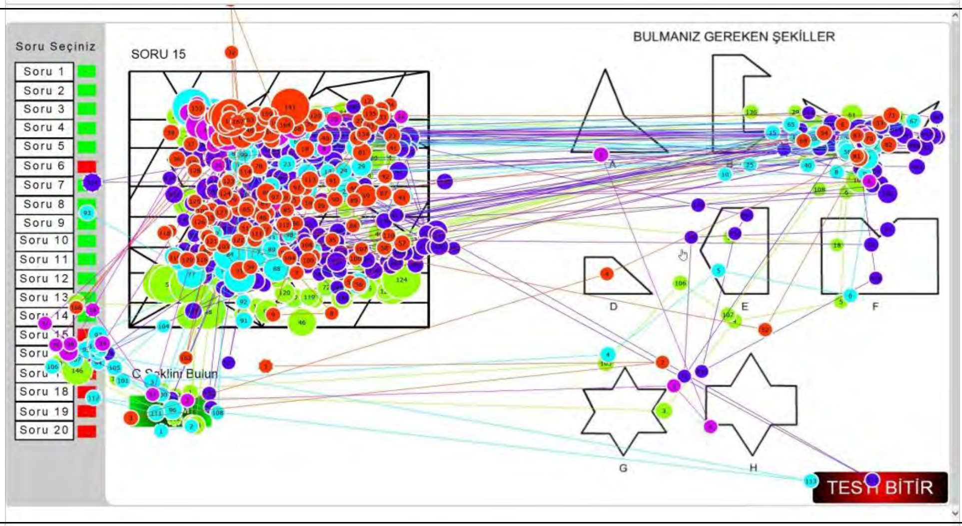
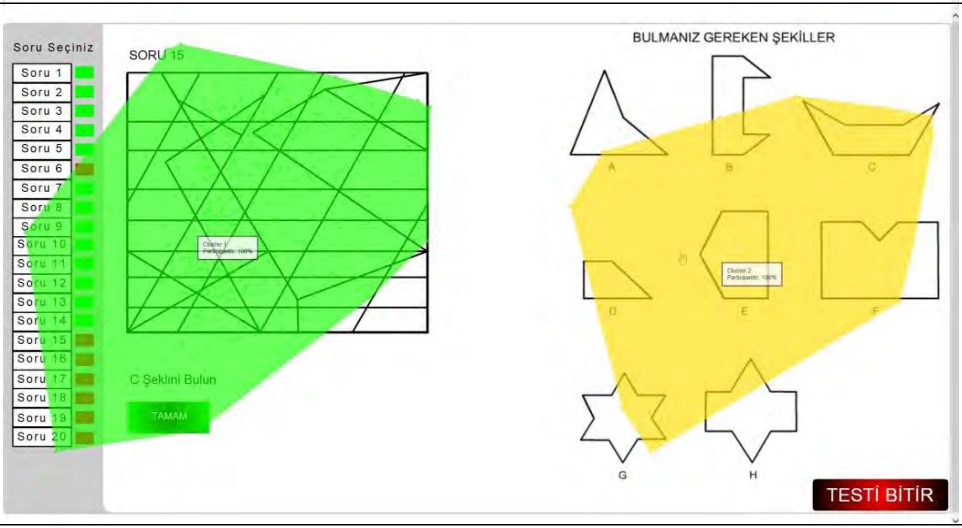
After all the questions are completed, the preservice elementary teachers must click on the "FINISH TEST" button. After clicking the button, the program checks the answers and displays the number of correct answers on the screen. In addition, after the button is clicked, the program sends the 20 questions with the ID number, gender and group of the preservice teacher to the server where the program is running one by one as correct or incorrect. As a result, information about which question was answered correctly and which question was answered incorrectly for each preservice teacher can be recorded on the server. If the preservice teacher completes 20 minutes from the beginning of the time limit, the program automatically notifies the preservice elementary teachers that the time is up and evaluates the questions done up to that point. The system also considers the questions not done as incorrect.

Usability of the Computer Version of the Group Embedded Figures Test

The general purpose of usability testing is to make a designed system available to potential users and to monitor their performance during the usage process. According to Rubin (1994), usability testing has six basic elements: 1-developing test objectives, 2-selecting a sample of potential users, 3-establishing an authentic working environment, 4-observing the selected sample while using the system, 5-collecting quantitative and/or qualitative data based on observation, 6-analyzing the data and performing the appropriate procedures for the purpose of the test. Eye tracking device and software were used for usability for these purposes. The Tobii X2-30 Eye Tracking device, which was provided with the support provided by Bolu Abant Izzet

Baysal University Scientific Research Projects unit and Tobii Studio® software suitable for this hardware were used as eye tracking tools. Tobii Studio® software is a software developed by TOBII that converts the information received from the receiver and reflective infrared cameras on the computer or monitor into visual and numerical data, records it and provides various tools for analyzing this data later (IBE, 2018c). The visual data provided by this software include heat maps, gaze plots and clusters (See Table 2).

Table 2. Sample visual data obtained from Tobii Studio software

Visual Data	Example Situation
Heatmap	
Gaze plot	
Cluster	

Participants

A total of 252 preservice primary school teachers studying at the Department of Primary Education of a university in the Western Black Sea and Central Anatolia Regions, who had taken the Computer I and II courses, participated in the study. The study was completed in the spring semester of 2017-2018. The reason why these preservice elementary teachers were selected for the study was that they had acquired basic computer-related skills by taking Computer I and II courses. In this way, it was tried to equalize the preservice elementary teachers who answered the computer version of the test in terms of computer skills.

Studies on keyboard and mouse usage were conducted with the participants who participated in the study. In addition, "CSPS" was applied to all of the preservice elementary teachers participating in the study. By calculating the averages and standard deviations of this scale, outliers were discarded and 94 female and 31 male preservice elementary teachers with the highest averages among 252 preservice elementary teachers were identified. These preservice elementary teachers were randomly divided into 3 different groups as shown in Table 3.

Table 3. Distribution of preservice elementary teachers in the formed groups according to their gender

	Female	Male	Total
Group 1	29	9	38
Group 2	27	10	37
Group 3	38	12	50
Total	94	31	125

One-way analysis of variance was used to determine whether there was a significant difference between the groups in terms of "CSPS". It was concluded that there was no statistically significant difference between the groups determined in this way (See Table 4).

Table 4. Analysis of variance results according to the groups' BPS scores

Score	Group	N	$\bar{X}$	s	Source of Variances	Sum of Squares	df	Mean Squares	F
Computer Self Efficiency	G1	38	57.58	8,41	Between Gr.	9,62	2	4,81	.077
	G2	37	56.89	8,79	Within Gr.	7584.51	122	62.17	
	G3	50	57.08	6,68	Total	7594.13	124		

Since the groups were equal, they were randomly assigned to three groups: computer/computer, computer/pencil and paper and pencil/computer. The first group was administered the computer version of the GEFT twice (C-C). The second group was first administered the "GEFT-C" and then the "GEFT-P" (C-P), while the third group was first administered the paper-pencil version (P) and then the computer version (C) (P-C).

Implementation of Tests

Finally, the third group commenced with the paper and pencil version and then the computerised version for the second session. The second group took the computerised version of the test first and the paper and pencil version in the second session. In the initial session, the first group took the computerised version of the test and did so again in the subsequent session. Each session was segmented into 20 minutes and after the culmination of all lectures. The second sessions were conducted no less than 30 days following the first sessions. The preservice elementary teachers were provided with a paper and pencil version of the examination in line with the guidelines. The tests were distributed to the preservice elementary teachers, they were told that they had a total of 20 minutes to complete the sample questions and the tests were collected at the end of 20 minutes even though they could not be completed. The evaluation was done by the researchers by giving 1 if correct and 0 if incorrect. In the computer version of the test, after the sample question was made and the start test button was clicked, 20 minutes was given and at the end of 20 minutes, the participant was not allowed to take any further action with a warning indicating that the time on the computer was over. In the computer version, the answers given by the participant were evaluated as correct and incorrect and sent to the server automatically.

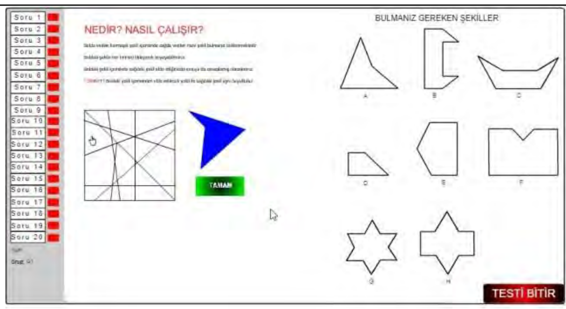
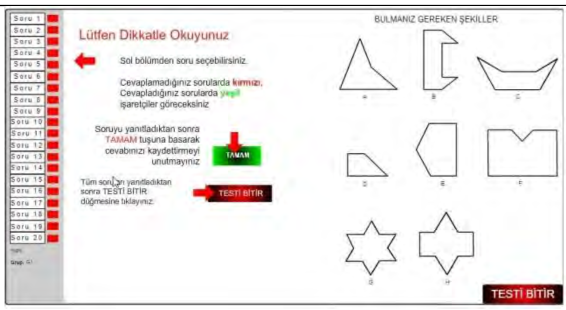
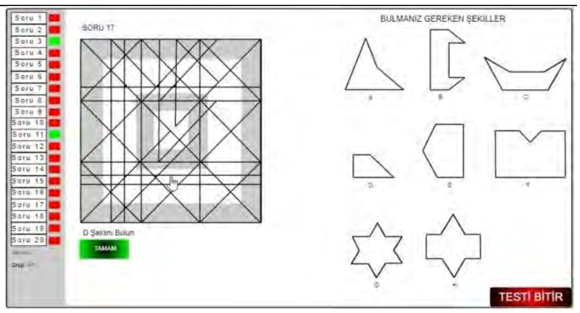
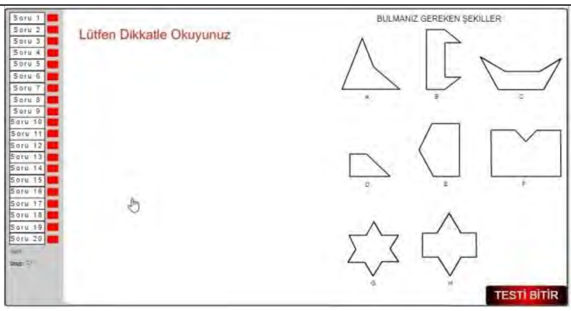
Findings and Interpretations

In this section, findings related to the usefulness of the computer version of the GEFT, the equivalence between the paper and pencil and computer versions and the reliability of the computer version are presented.

Availability of the Computer Version of the GEFT

For this purpose, firstly, the computer version of the GEFT was administered to 10 preservice primary school teachers (5 female, 5 male) who participated in the pilot study of the computer version of the test and had the same profile as the actual participants of the study. During the application, Tobii X2-30 eye tracking device and Tobii Pro Software were used. After the participants' eye movements were recorded, the test was divided into 6 main scenarios (scenes) (Introduction, What is it, Attention, Questions, End, Result - See Table 5). Then, the heat map information of each participant in these main scenarios was analyzed to determine whether the participants focused on the appropriate areas on the test. In this way, the test was finalized.

Table 5. Main scenarios created for usability

 Introduction	 What is it?
 Attention	 Question 17
 End	 Result

In addition, the eye tracking records obtained after the usability application were analyzed. Table 6 shows the participants' weighted gaze sample percentages. This value is an indicator of the time it takes for the participant to focus into the screen and for one or both eyes to be correctly captured by the eye tracker and 91% was chosen as the threshold value for this study.

Table 6. Examples of participants' weighted gaze patterns

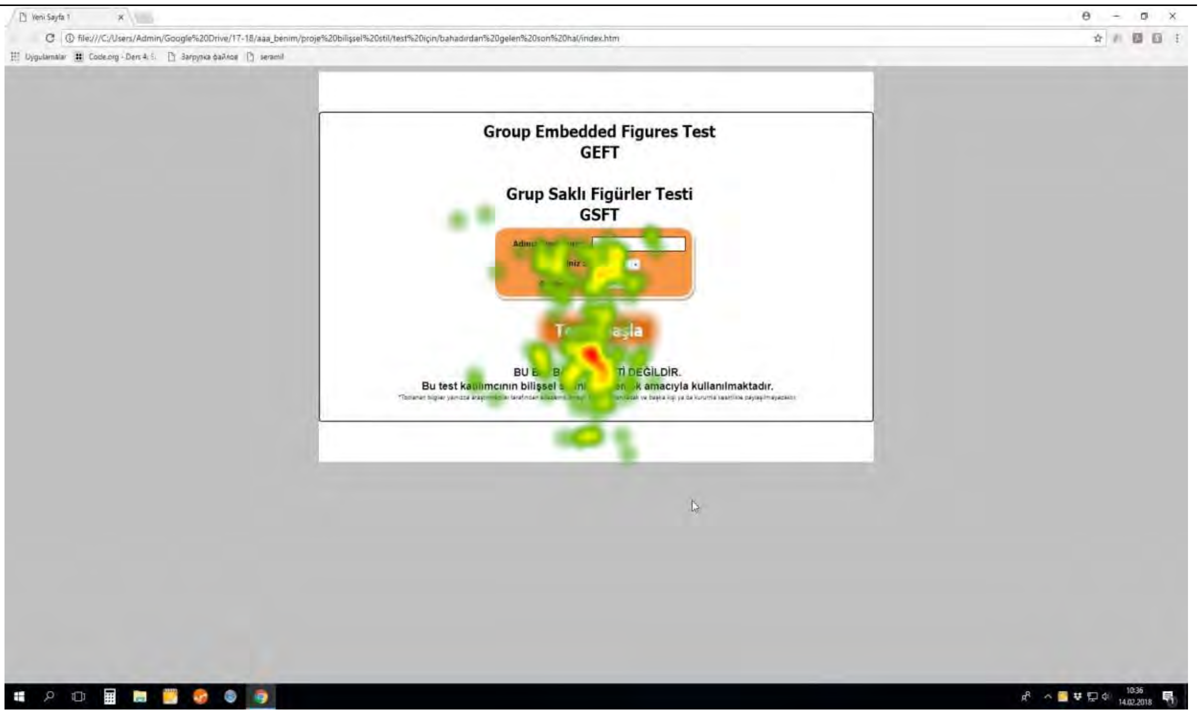
Participants	Gender	Weighted Gaze Samples %
F1	Female	96
F2	Female	94
F3	Female	95
F4	Female	91
F5	Female	97
M1	Male	92
M2	Male	96
M3	Male	98
M4	Male	96
M5	Male	96

In order not to give the real names of the preservice elementary teachers who participated in the usability study, the codes in Table 6 were created for each student.

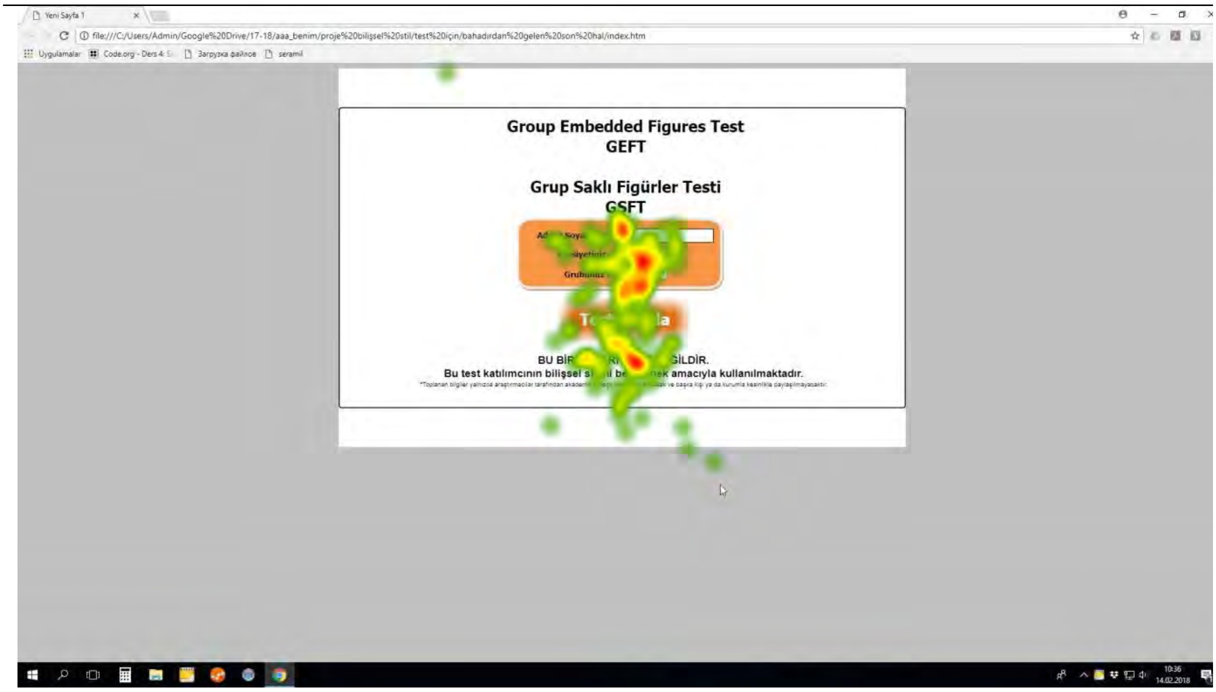
"Introduction" main scenario

In the "Introduction" main scenario, the name of the test and its purpose are briefly explained, as shown in Table 5. On this screen, the participant is expected to read the explanations and write his/her name, surname, gender and group. Table 7 shows the regions that preservice elementary teachers focused on in this scenario according to their gender.

Table 7. Heat map data by gender in the "Introduction" scenario



Introductory scenario female



Introductory scenario male

When Table 7 is analyzed, it is seen that both male and female preservice elementary teachers focused on the area where the name, surname, gender and group should be written and the area where the “Start Test” button is located. In the writing section at the bottom, it was revealed that they focused only on the statement “THIS IS NOT AN ACHIEVEMENT TEST.”, which was written in capital letters with a large font size. It is seen that the area where the purpose of the test is written and the information collected is almost never focused on. In addition to these, it can be said that the name of the test was not looked at carefully at all.

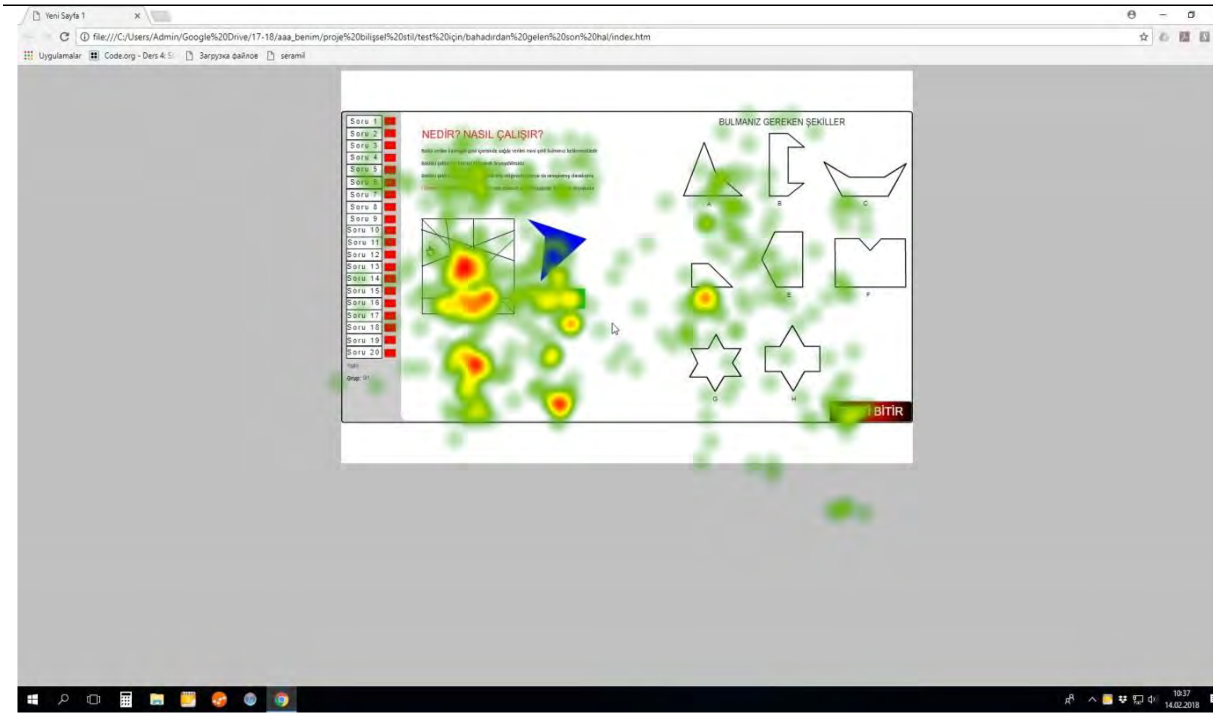
For these reasons, while finalizing the test, changes were made in the introduction part. First of all, the introduction part of this test, which runs on a browser, used to cover a certain area of the browser as seen in Table 7, but in the new version, it has been ensured that it covers the entire browser. In addition, the font sizes of the purpose and explanation sections were enlarged and placed above the title section, which was also enlarged (See Figure 6).

Figure 6. Final version of the input part of the test

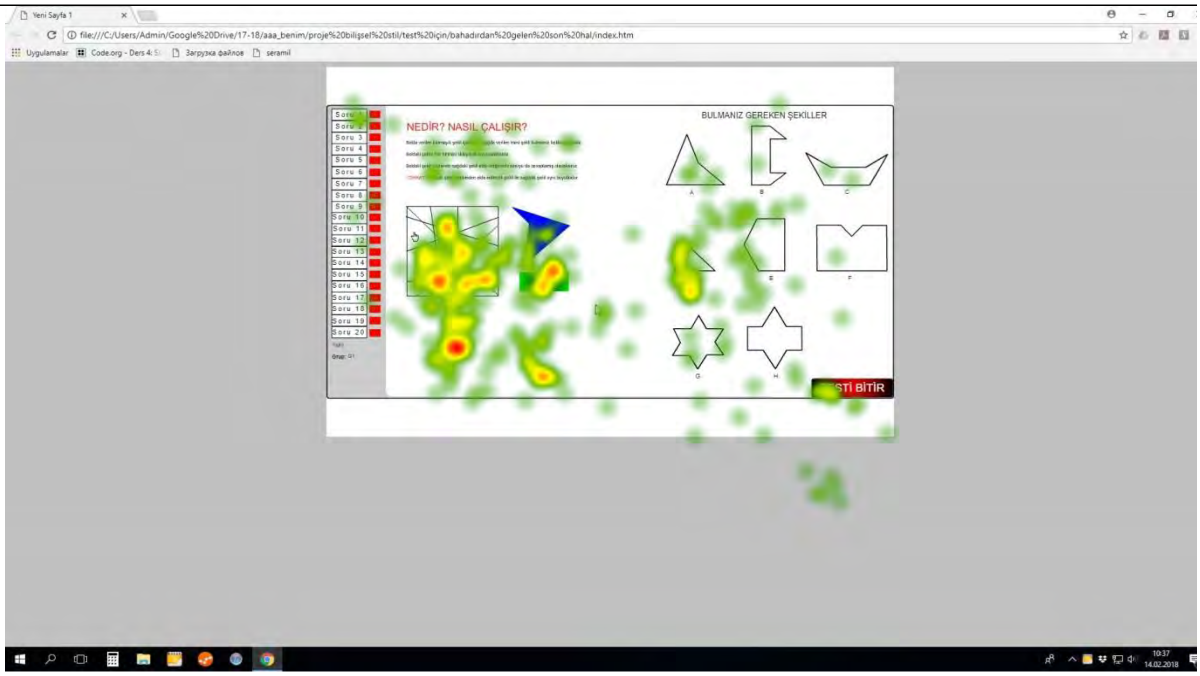
"What is it" main scenario

After the introduction of the test, the "What is it? How does it work?" section is presented to the participant. In this section, there is a small animation about how to answer the test. In the animation, the cursor in the form of a hand finds the blue shape on the right in the mixed region next to it and clicks on it. As it clicks, the white areas turn blue in the clicked part. After finding the shape in the animation, the "OK" button is pressed and the "Replay" and "Go to Next Page" buttons are seen in the mixed shape. Table 8 shows the regions that preservice elementary teachers focused on in this scenario according to their gender.

Table 8. Heat map data by gender in the "What is it" scenario



What's the scenario females



What is the scenario males

When Table 8 is analyzed, it is seen that in this scenario, both male and female preservice elementary teachers watched the animation and tried to focus especially on the region where the cursor moved. After the end of the animation, it was revealed that females also focused on the explanations at the top, although more so. However, as seen in Table 8, this focus remained at a lower level than the animation. In addition, it is understood from the screenshots recorded by the software that the preservice elementary teachers checked the other parts of the screen (the part with the questions, the part with the shapes to be searched and the part with the "Finish Test" button) after reading the explanations. Another point that draws attention here is that the preservice elementary teachers tried to find the blue shape among the shapes to be searched after watching the animation. For this reason, while finalizing the test, the blue shape was changed and a blue shape that was not similar to the shapes to be searched and more suitable to the original was found among the complex shapes with the help of animation. Also, the "What is it? How does it work?" section was also modified. The buttons that appeared on the screen after the animation was over were shifted to the right and their names were changed to "Watch Again" and "Next Page". Since these buttons were moved to the right and the participants tried to look for this blue shape among the shapes to be searched for, the "Shapes You Need to Find" section was removed from this section. In addition, the font size of the explanations was enlarged to make them a little more attractive (See Figure 7).

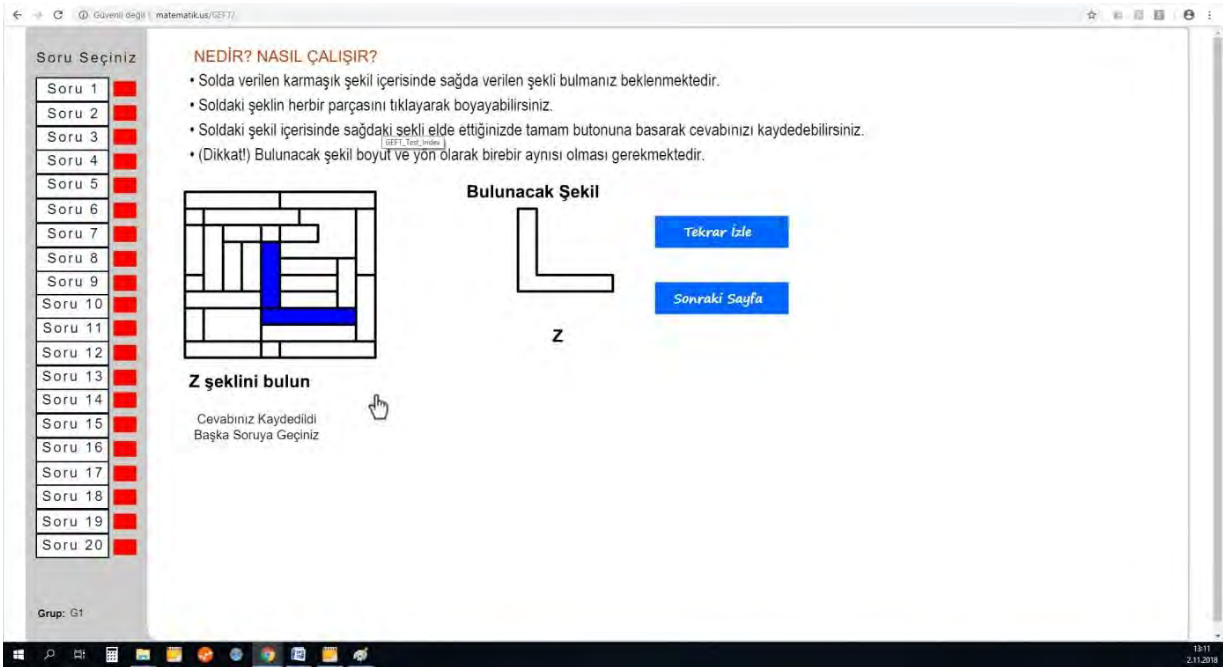
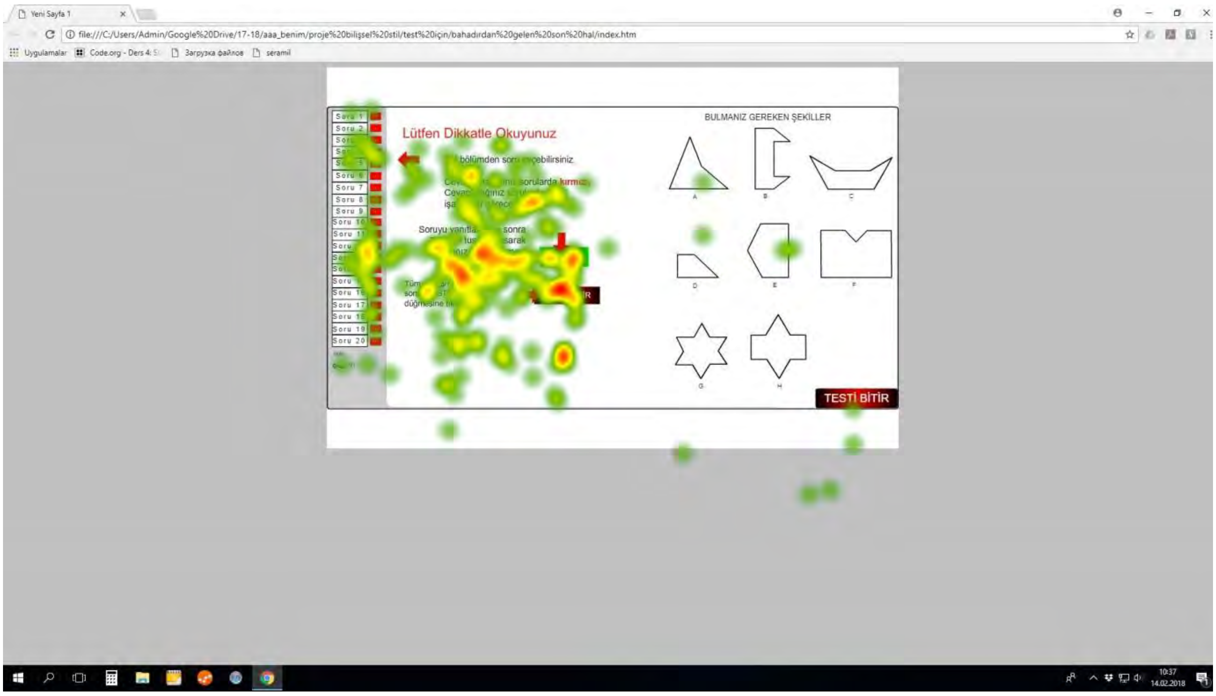


Figure 7. Final version of the "What is it? How it works" section of the test

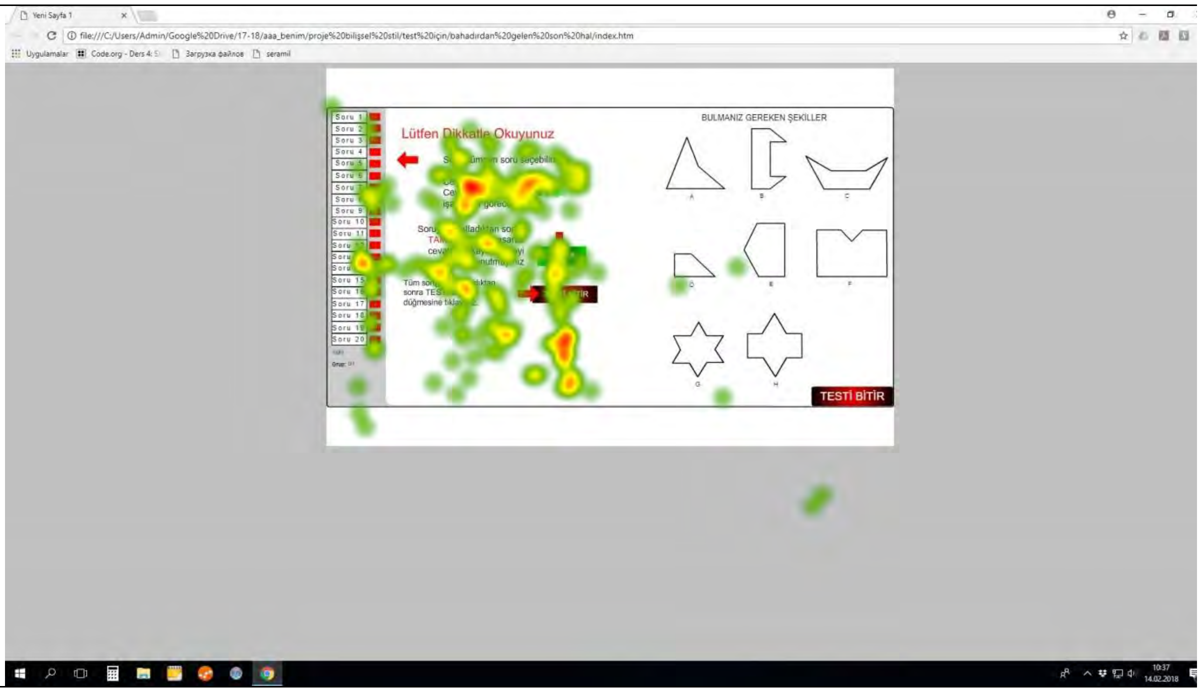
"Attention" main scenario

In the "Please Read Carefully" section of the test, there is an animation explaining how to choose the questions in the test, what to do after answering and after all the questions are finished and what the colors next to the question items mean. Table 9 shows the regions that preservice elementary teachers focused on in this scenario according to their gender.

Table 9. Heat map data by gender in the "Attention" scenario



Attention scenario female



Attention scenario male

When Table 9 is analyzed, it is seen that both male and female preservice elementary teachers focused on the explanations given. It was revealed that the focus sometimes shifted to the "Shapes You Need to Find" section, albeit very slightly. For this reason, in the final version of the test, the "Shapes You Need to Find" section was removed from this section. The final version of this section is shown in Figure 8.

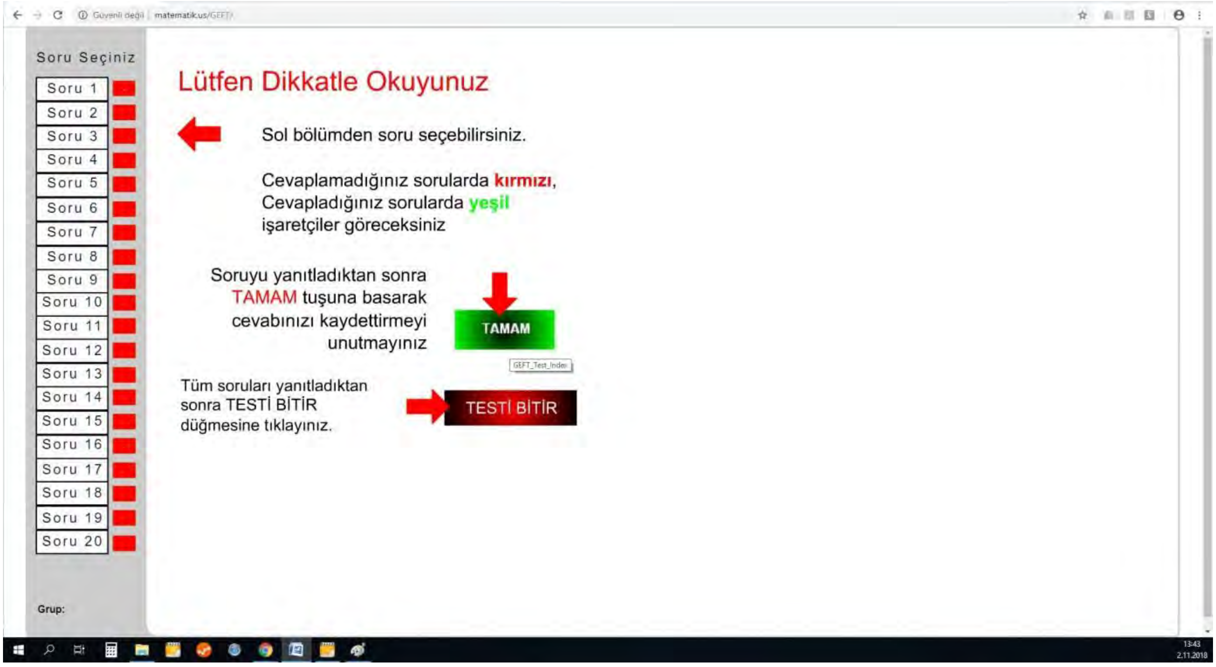
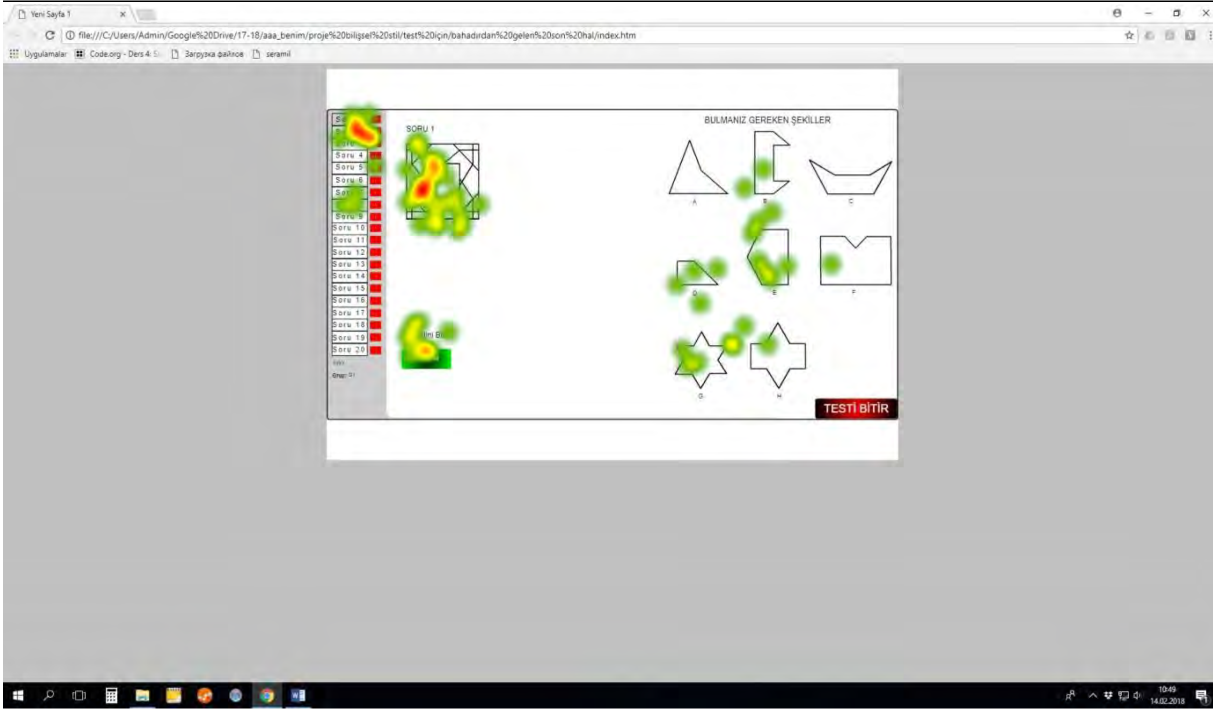


Figure 8. Final version of the "Attention" part of the test

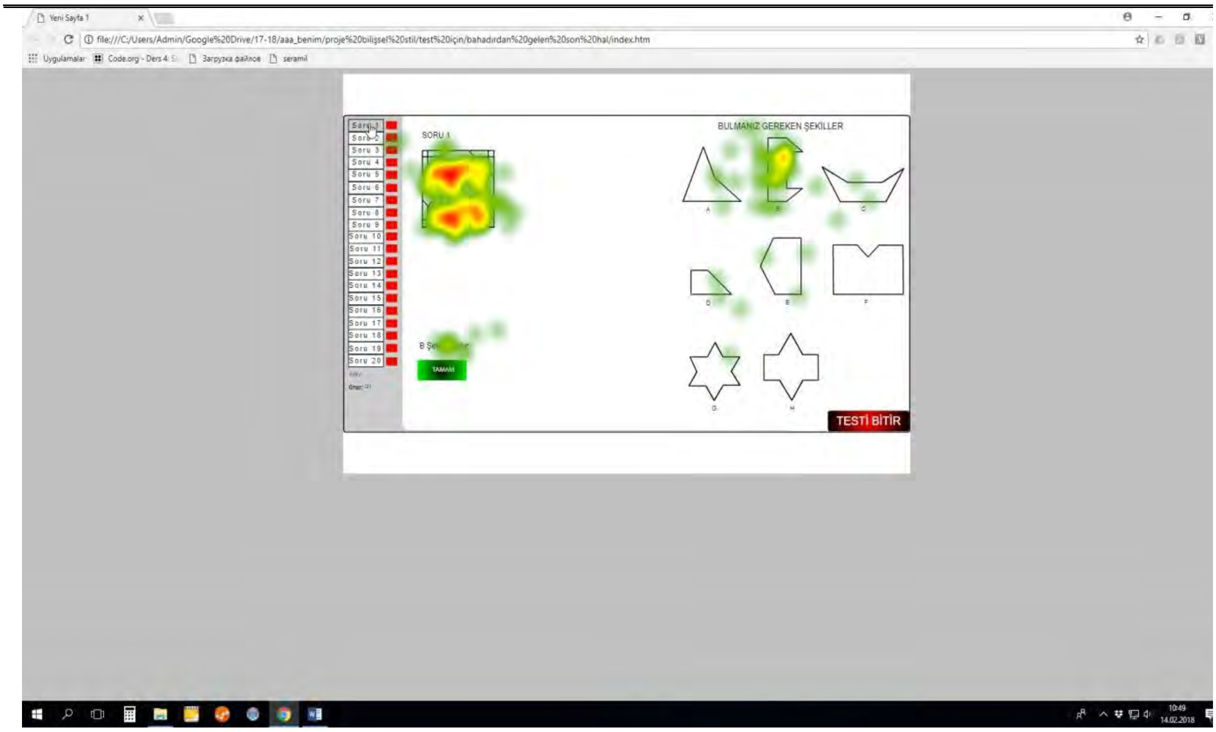
"Questions" main scenario

In this main scenario, although 18 questions were analyzed, interpretation was made on questions 1 and 5 as an example. In the "Questions" section of the test, participants are asked to select the question from the left side and find the shape they are looking for in the complex shape in the "Shapes You Need to Find" section. Table 10 shows the regions that preservice elementary teachers focused on in this scenario according to their gender.

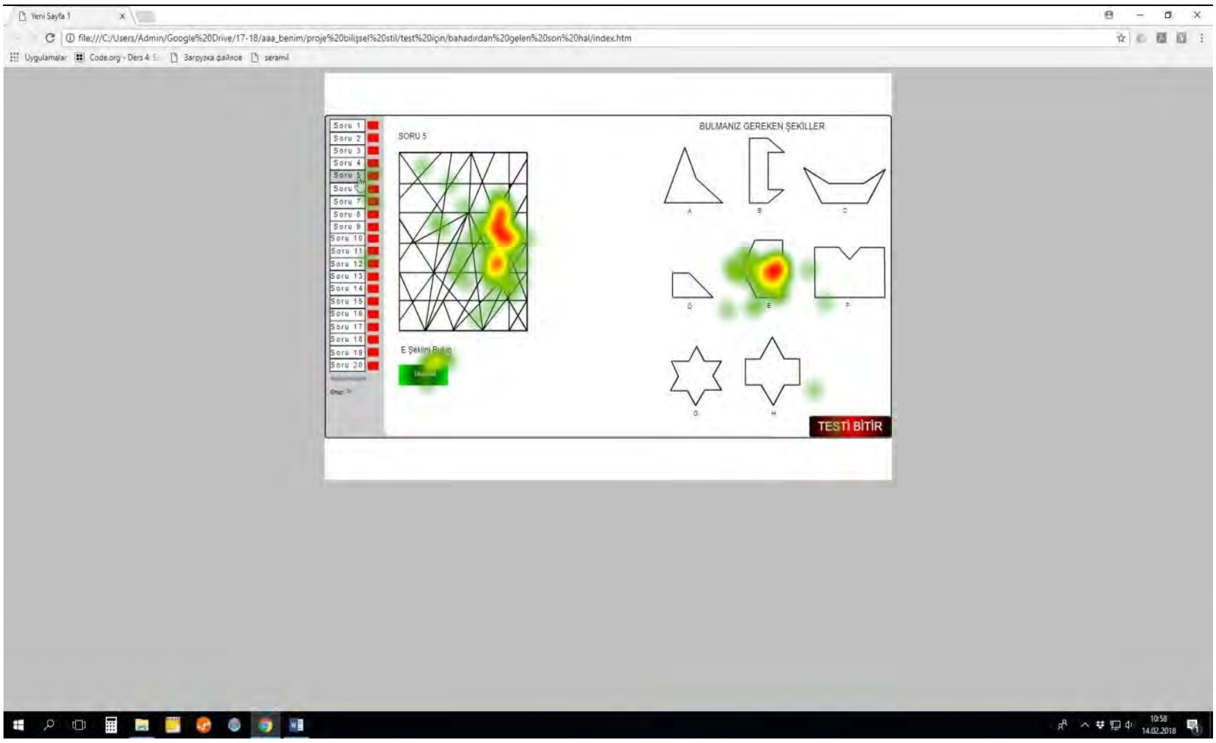
Table 10. Heat map data by gender in the "Question 1 and Question 5" scenario



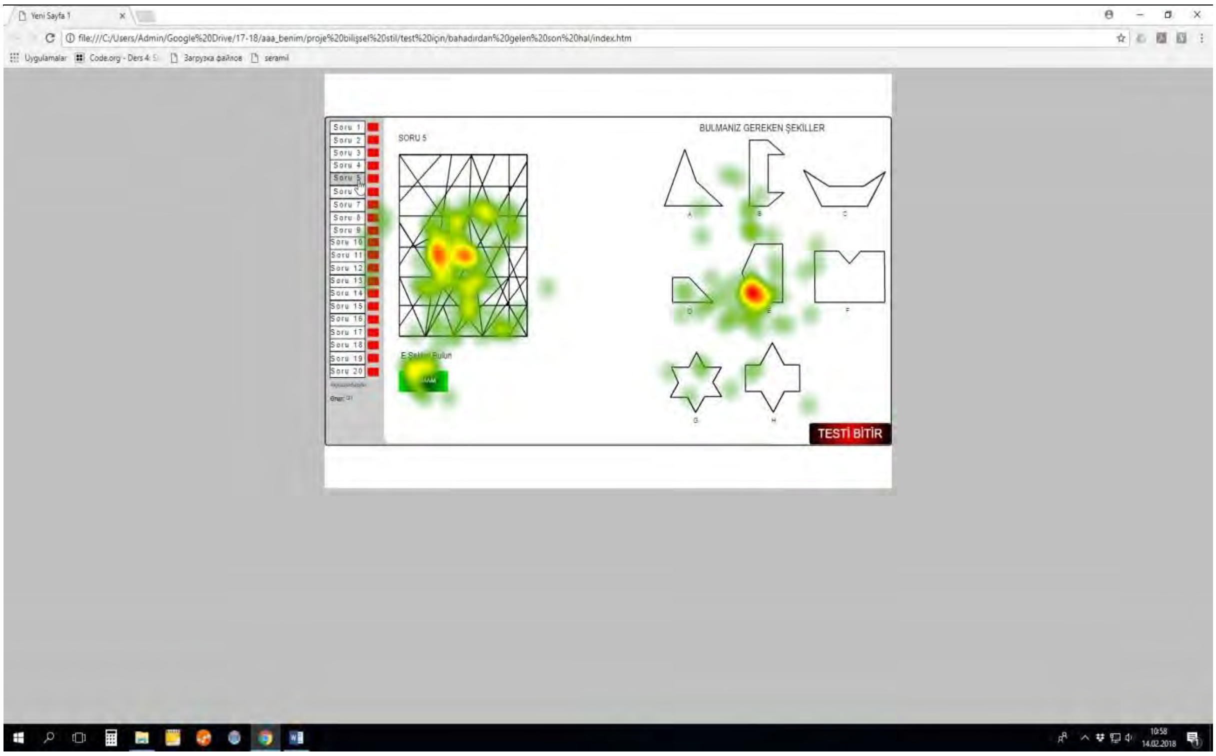
Question 1 scenario females



Question 1 scenario males



Question 5 scenario females



Question 5 scenario males

When Table 10 is examined, it is seen that both female and male preservice elementary teachers focused on the shape they needed to find in both question 1 and question 5. In addition, since they searched for this shape in the complex shape, it is noticeable that the heat map is more intense on the complex shape. Based on this, it can be said that the participants focused on the questions as expected. For these reasons, not much change was made in the question sections. Only the questions were made to cover the scanner and the images were enlarged. During this enlargement process, it was ensured that the shapes that should be present were placed in a complex manner with their full size (See Figure 9).

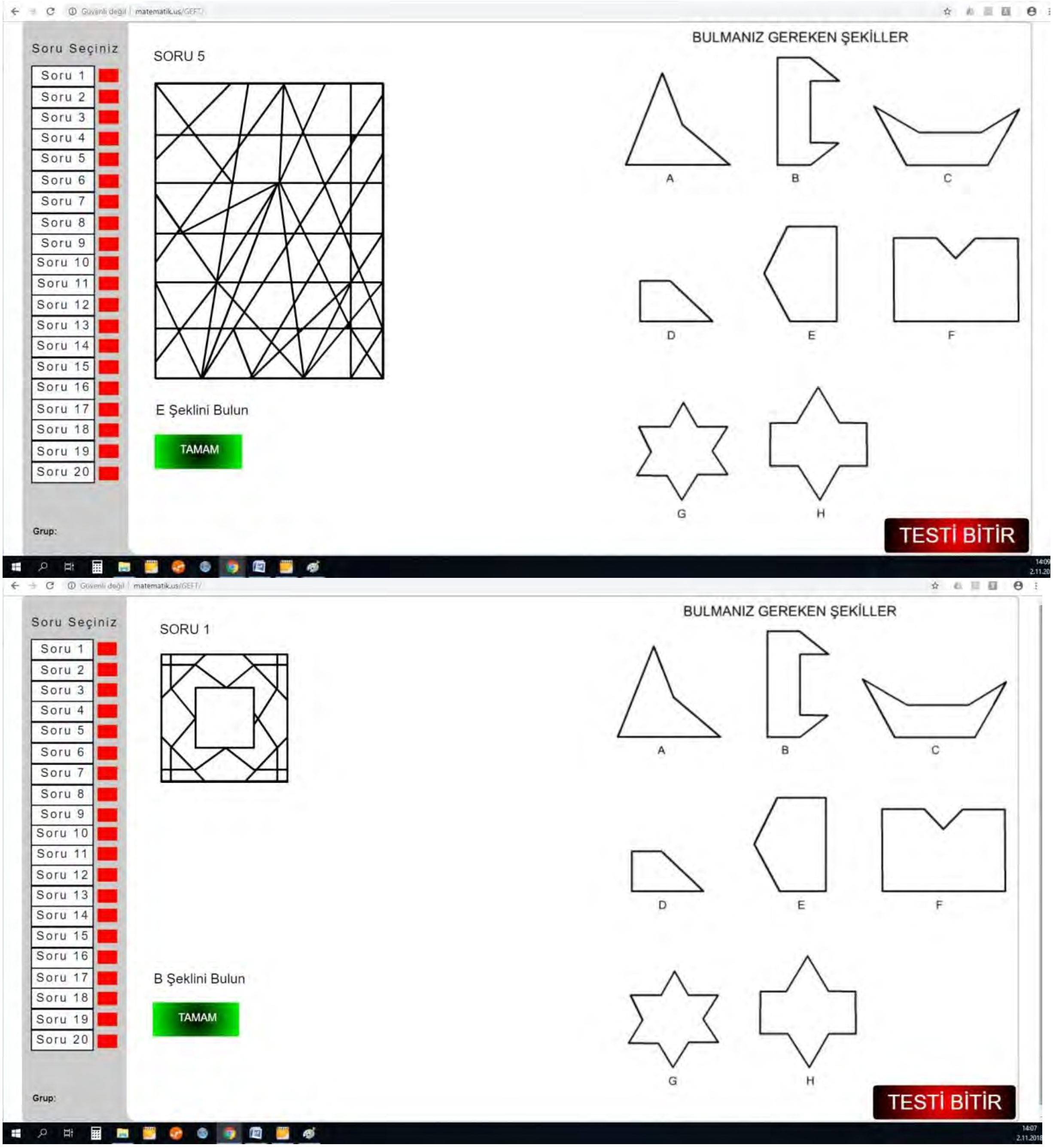
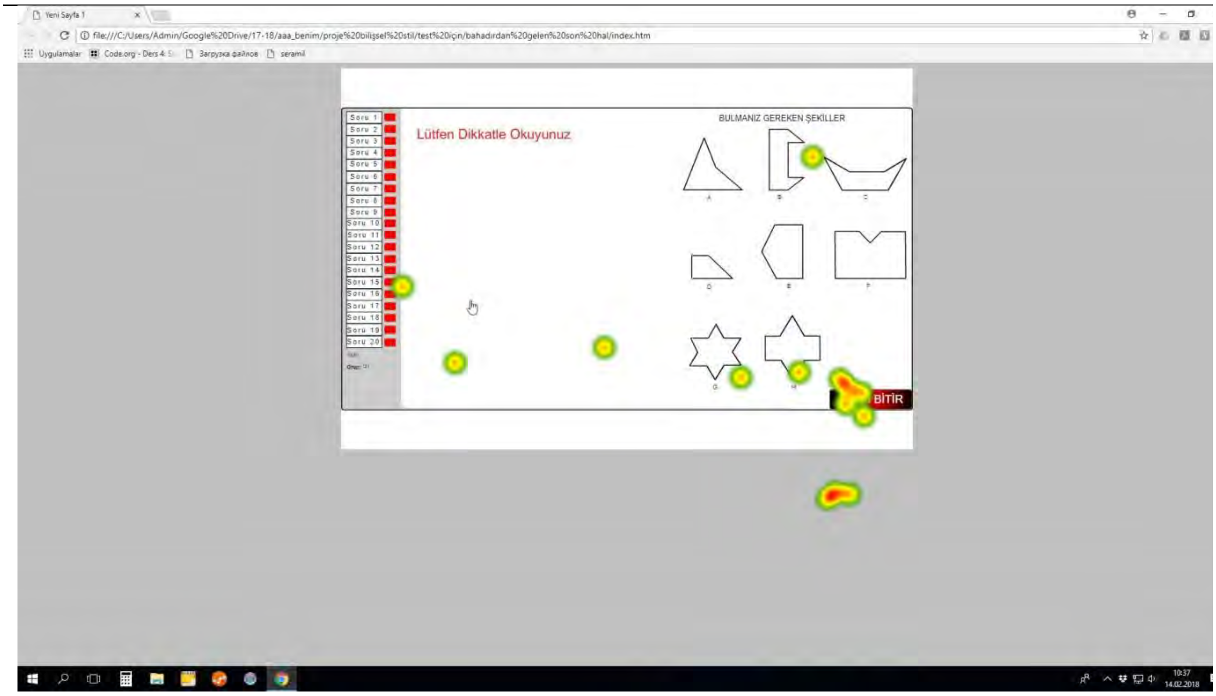


Figure 9. Final version of questions 1 and 5 of the test

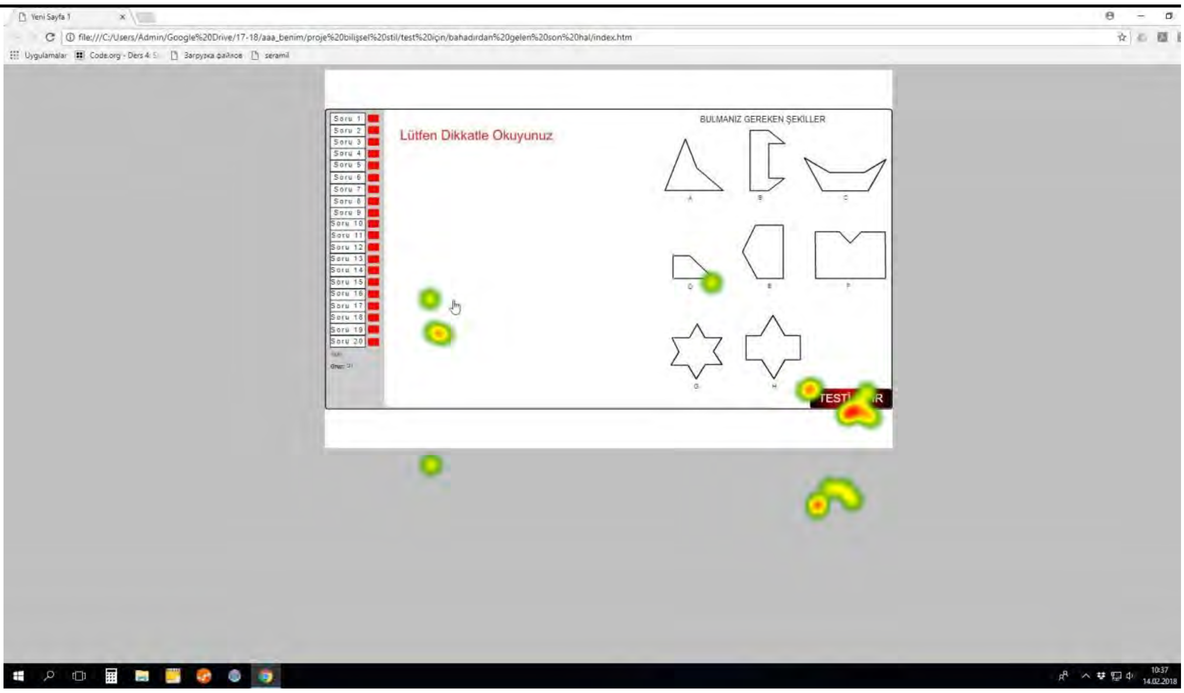
“End” and “Result” main scenario

In the end main scenario, the test is finished and the result screen appears after the preservice elementary teachers click on the “Finish Test” button after answering all the questions in the test. The result main scenario includes the part that comes after clicking the “Finish Test” button. In this section, the preservice elementary teachers first see the number of correct answers, which questions they answered correctly and which questions they answered incorrectly and then the page containing thanks. No major changes were made in these sections due to the intense focus of the preservice elementary teachers on the expected parts. Table 11 shows the regions that preservice elementary teachers focused on in these scenarios according to their gender.

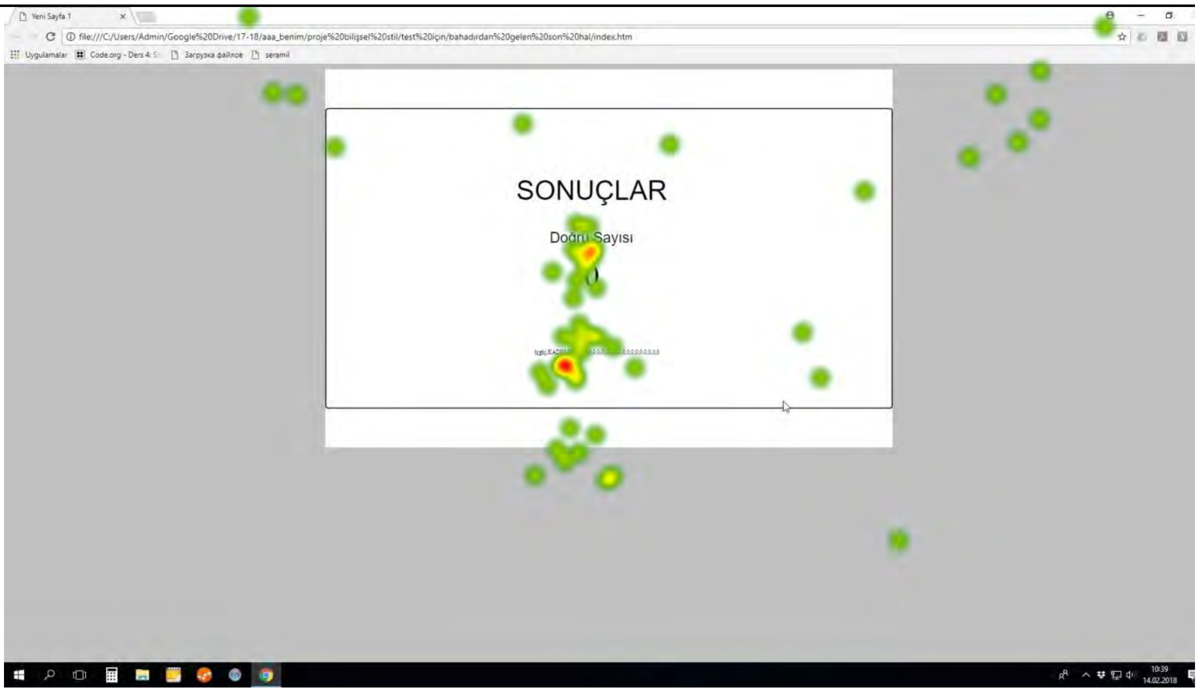
Table 11. Heat map data by gender in the “End” and “Result” scenarios



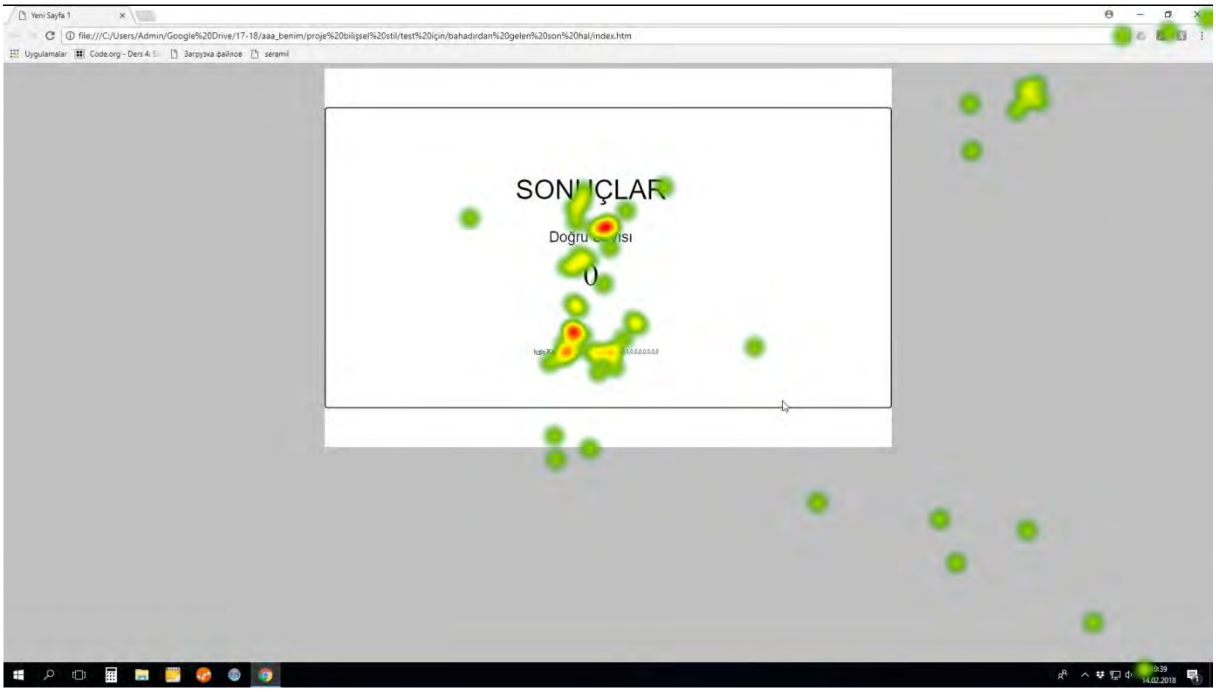
End scenario females



End scenario males



Result scenario females



Result scenario males

When Table 11 is analyzed, it is seen that both female and male preservice elementary teachers focused on the parts they were expected to focus on in both the ending and the scenarios. Therefore, not much change was made in the question sections. When the “Finish Test” button is clicked, the warning “Are you sure you want to finish the test?” appears as shown in Figure 9, although it was not in the old version. In addition, the result and end scenarios were made to cover the browser and the images were enlarged (See Figure 10).

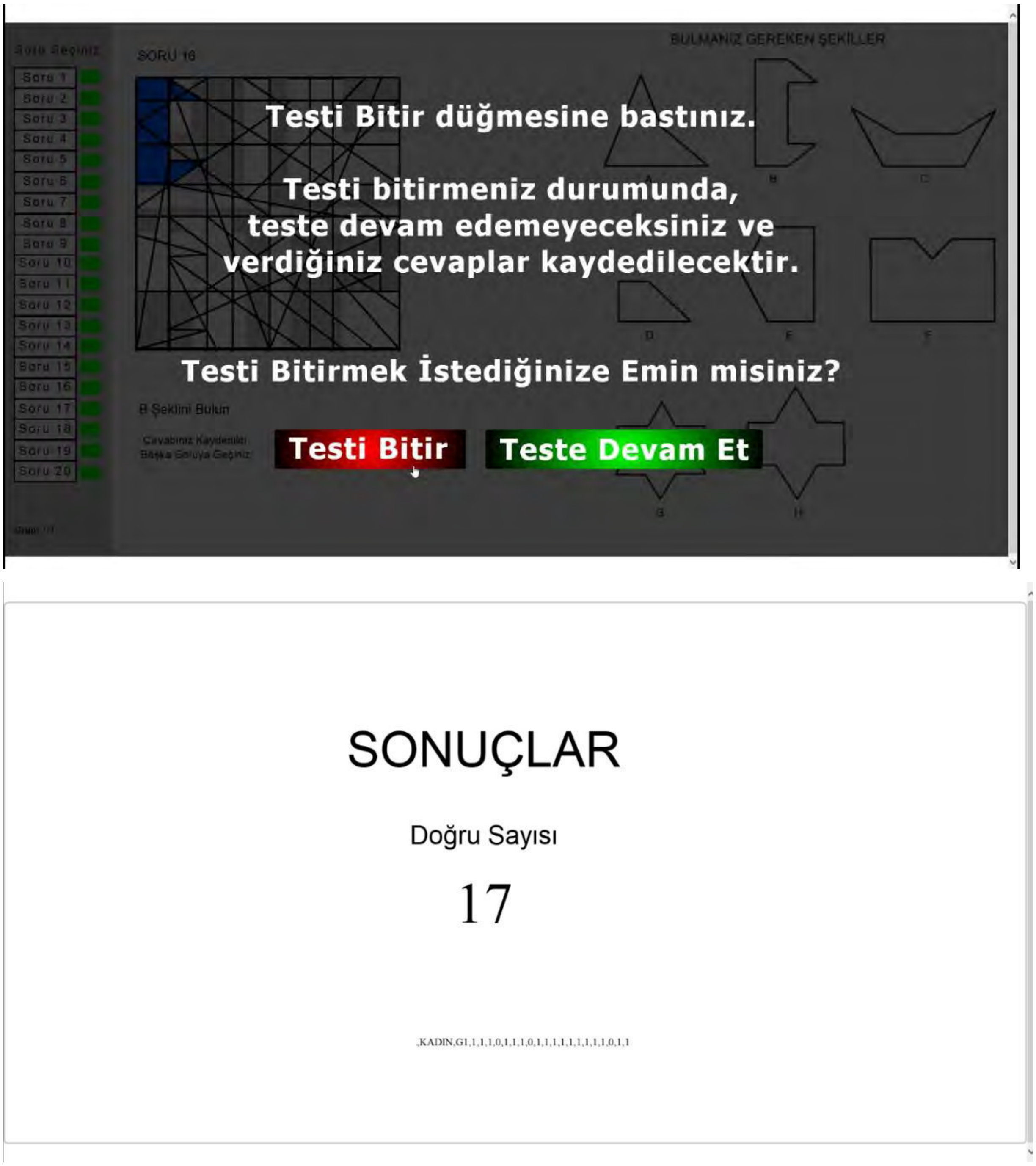


Figure 10. Final version of End and Result scenarios

Finalization of the test

The relevant changes were made in the sections examined in the context of the above scenarios and the test was finalized. While finalizing the test, arrangements were made to ensure that it appears on the full screen without the need for a scroll bar.

Test Statistics for the Computer Version and Paper and Pencil Version of the GEFT

The test statistics of the scores obtained by the participant groups separately from the paper-and-pencil and computer versions of the GEFT were found and these data are presented in Table 12.

Table 12. Test statistics of different versions of GEFT by groups

Group	GEFT Version	N	$\bar{X}$	s	min	max	KR-20
Group 1 (C-C)	Computer	38	7,61	4,09	0	17	.80
	Computer	38	9,32	4,41	1	17	.82
Group 2 (C-P)	Computer	37	6,86	3,54	2	15	.75
	Paper and Pencil	37	9,35	3,43	4	18	.70
Group 3 (P-C)	Paper and Pencil	50	9,42	4,15	1	18	.81
	Computer	50	10,50	3,75	2	18	.75

When Table 12 is examined, it is seen that the KR-20 internal consistency coefficients of all tests applied to the groups are higher than .70. Therefore, it can be said that the measurements obtained as a result of the tests applied are reliable (Cortina, 1993). In addition, there was an increase in the second applications in all groups. Although the second test was conducted at least one month later, the reason for this increase may be the experience gained in the first applications. To reveal whether there is a relationship between the scores obtained as a result of the two applications in each group, the normality of the scores was examined first. Since the skewness and kurtosis coefficients were between -2 and +2 according to the groups, the distributions were accepted as normal (George, 2011) and Pearson Product Moment correlation coefficient was calculated to reveal the relationship between the tests. The results are presented in Table 13.

Table 13. Relationship between different versions of GEFT

			2nd Application - Computer	2nd Application - Paper and Pencil	2nd Application - Computer
Group 1 (C-C)	1st Application - Computer	Pearson	.864*		
		p	.000		
		N	38		
Group 2 (C-P)	1st Application - Computer	Pearson		.745*	
		p		.000	
		N		37	
Group 3 (P-C)	1st Application – Paper and Pencil	Pearson			.748*
		p			.000
		N			50

*p<.01

As a result of the test, a highly significant positive correlation was found between the 1st and 2nd tests applied to the computer/pencil/paper and paper/pencil/computer groups (r2 =.745, r3 =.748, p<.01). Based on these results, it can be said that the different versions of the GEFT for both groups were found to be equivalent in terms of the participants' performances. In other words, it can be stated that the participants showed similar performances in the Paper-Pencil and Computer versions of the GEFT.

In addition, a test-retest reliability was also examined for the computer version of the GEFT over the 1st group comparing the computer/computer version of the GEFT. The correlation analysis showed that the relationship between the first and second administration of the test was highly positive (r1 =.864). Based on this, it can be said that the computer version of the GEFT prepared by the researchers is a reliable test.

Whether the reliability of different versions of the GEFT applied on groups two and three differed or not was examined with the COCRON package created with R commands based on the methods defined by Feldt, Woodruff and Salih (1987). The results of this test are given in Table 14.

Table 14. Comparison of the reliability of different versions of the GEFT

Group	GEFT Version	N	k	KR-20	X^2	p
Group 2 (C-P)	Computer	37	20	.75	.604	.437
	Paper and Pencil	37	20	.70		
Group 3 (P-C)	Paper and Pencil	50	20	.81	1.874	.171
	Computer	50	20	.75		

When Table 14 is examined, it is found that there is no significant difference between the reliabilities obtained as a result of the Computer and Paper and Pencil versions of the GEFT applied to the second group and the Paper and Pencil and Computer versions of the GEFT applied to the third group. In line with these findings, it can be said that the Paper-Pencil and Computer versions of the GEFT are equivalent in terms of reliability values.

Scientific Developments and/or Results of the Project

It was revealed that studies can be carried out on the usability of tests in the transfer of psychometric tests to the computer environment by including the eye movements of individuals in the process by using eye tracking device support in the transfer of paper-pencil tests to the computer environment. A computer version of the GEFT, which is used to reveal cognitive styles, has been created that can be applied more easily than the paper-and-pencil version and is equivalent.

Conclusion

In this study, it was aimed to create a computer-assisted version of the GEFT that is at least as effective as the paper-and-pencil version in measuring cognitive styles. For this purpose, firstly, a computer version of the GEFT was created and the steps for the usability of this version were tested. Then, it was examined whether the forms were equivalent in terms of the ability to use computer-based tests as a substitute for paper-and-pencil tests. It was found that there was a high level of correlation between the two versions. In addition, the KR-20 reliability coefficients of the paper-and-pencil and computer versions of the GEFT were compared separately. It was concluded that there was no significant difference in these comparisons. Thus, this study revealed that the paper-and-pencil and computerized versions of the GEFT can be accepted as equivalent in terms of psychometric properties and can be used interchangeably. From this point of view, it is thought that transferring the paper-and-pencil tests to the computer environment will facilitate the application and evaluation process.

Recommendations

By increasing computer-based test applications, it can be examined whether there is a change in the performance of students with different cognitive styles in tasks addressing different learning domains.

The opinions of the students who performed both the paper-and-pencil and computer version of GEFT can be obtained about these applications. In addition, different studies can be conducted by analyzing the students' behaviors while performing these applications with observation technique.

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CHAPTER 2

Modeling Field Dependent and Field Independent Individuals: An Eye Tracking Study [2]

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Introduction

The concept of cognitive style is generally defined as the way of approaching problems, the way people solve problems, think, perceive and remember. Cognitive style determines individual differences in how information from the outside world is received, processed, stored and used. It can be effective in all cognitive processes, such as perception, memory, thinking and problem-solving. Many cognitive styles have been proposed with very different theoretical approaches and techniques. One is the field dependence and field independence cognitive styles proposed by Witkin, Moore, Goodenough and Cox (1977). Witkin and Goodenough (1981) posit that individuals with domain-dependent cognitive styles tend to rely on an external frame of reference, whereas individuals with domain-independent cognitive styles tend to rely on an internal frame of reference. The concept of field dependence and field independence is characterised as an individual's inclination towards being influenced by external perceptual bases in cognitive and social engagements. Individuals who are field independent exhibit greater success compared to those who are field dependent when engaging in "cognitive restructuring" processes. These processes involve the identification and analysis of the complex structure of a given field, the extraction of specific elements from its complex entirety, and the differentiation between the elements of the field. Subsequently, individuals must reorganize the field according to the task's requirements.

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Field independent students are defined as analytical, competitive, individualistic, task-oriented, highly intrinsically motivated, spatially oriented, detail-oriented and visually oriented individuals (Fritz, 1994; Reiff, 1996; as cited in Altun, 2003). Field dependent students, on the other hand, are defined as passive students who are fond of group work, sensitive to social interaction, seek extrinsic motivation, are non-verbal expressive, take what is presented to them (Liu & Reed, 1994; Lyons-Lawrence, 1994; Riding & Cheema, 1991; as cited in Altun, 2003). Altun, 2003).

During the learning process, it is imperative to acknowledge that the cognitive styles of diverse individuals cannot be disregarded. Consequently, learning environments may need to be tailored to suit individuals' learning preferences. It has been found that field dependent individuals may prefer computer environments where information is well compiled and presented with plenty of examples; on the other hand, it has been revealed that it may be effective for field independent individuals to create their learning processes with active participation in accessing information (Altun, 2003). The most basic idea in the educational environment is that there are individual differences among students and that these differences should be used in creating and organizing educational environments.

The Group Embedded Figures Test (GEFT) (Witkin, Oltman, Raskin, & Karp, 1971; Witkin et al., 1977), which is based on finding simple figures embedded in complex figures, is used to determine the cognitive styles of individuals. As a result of the Group Embedded Figures Test (GEFT), individuals' cognitive styles can be determined as "Domain Dependent" or "Domain Independent".

Following the computer revolution's introduction into schools, computer technology developments have led to the emergence of computer-assisted testing. Thanks to computer-assisted tests, test results can be obtained and evaluations can be made the fastest way possible. It is stated that such tests have a more concrete structure than paper and pencil tests. In addition, once the infrastructure is established, it can be quickly reorganized and used in different fields (İmamoğlu, 2007).

Computer Based Tests

Computer applications in education have increased considerably in recent years. Computers are used as an essential educational tool in many schools. Computer technologies facilitate researchers and teachers in computer-based instruction, assessment, file keeping and school management. One of the most critical areas of computer use in education is computer-based assessments.

Computer-based assessments create an environment that allows students to participate in exams, teachers to structure exam questions and teachers to communicate exam results. With the widespread use of developing technology in educational institutions and increased interaction of students with technology, computer-based tests have become applicable. Flexibility in terms of time can also be provided with assessments in which the processes of designing, implementing and determining the results of exams are carried out in a computer environment via the Internet (Bayazıt, 2007; Sampson, 2000). It can be said that tests used within the scope of computer-based assessment in education have become widespread. It can be predicted that computer-based tests, which have started to be preferred as an alternative to traditional paper-and-pencil tests and have become widespread in exams held throughout the country (e-YDS, e-ALES, electronic driving license exam, etc.), will be used in the entire assessment process in the future. In this context, it becomes vital to prefer computer-based assessments in the assessment process by considering their advantages and disadvantages.

Eye Tracking Technology

Eye tracking is a technique aimed at monitoring and measuring eye movements of an individual to establish where they focus and for how long, along with providing insight into eye transitions in the region of interest (Poole & Ball, 2006). This method employs direct observation of ocular activity, which can qualify stimuli presentations and inform research in multiple fields, including psychology and marketing. The connection between eye movements and cognition has garnered the interest of researchers in various disciplines, including mathematics (Suppes, 1990), human-computer interaction (Poole & Ball, 2006; Rudmann, McConkie, & Zheng, 2003 as cited in Qutub, 2008), psychology (Nisbett & Miyamoto, 2005), and science education (Rudmann, McConkie, & Zheng, 2003 as cited in Qutub, 2008). Eye-tracking technology can offer academic researchers valuable insights and information pertaining to a range of subjects including mental imagery (Yoon & Narayanan, 2004), reasoning and decision-making (Gonzalez & Golenbock, 2003; Nisbett & Miyamoto, 2005), problem-solving (Salvucci & Anderson, 2001; Tai, Loher, & Brigham, 2006), and reading (Clifton, 2004; Schilling, Rayner, & Chumbley, 1998).

History of Eye Tracking

Eye tracking technology was first used in reading research over a century ago (Poole & Ball, 2006). Initially, electrodes were placed around the eye to measure eye movements before a metal ring was fitted around large contact lenses to cover the cornea and sclera of the eye. Eye tracking was quantified through the measurement of fluctuations in the electromagnetic field elicited by the metal ring's movements (Duchowski, 2003). Most contemporary eye-tracking systems utilise video cameras which record eye movements for the purpose of ascertaining the direction of the subject's gaze.

More advanced eye tracking systems, such as Tobii Technology, utilise sensitive cameras to track participants' eye movements on a monitor screen to ensure compatibility with the displayed content (Poole & Ball, 2006; Tobii Technology, 2017). Unlike standard computers, these systems feature a small video camera embedded beneath the screen. This sensitive camera utilises near-infrared light-emitting diodes to track and record the eye movements of viewers for the purpose of measuring various visuomotor behaviours (Tobii Technology, 2017). In practice, infrared lights are initially directed towards the participant's eye which results in strong reflections on the target eye, thus aiding the tracking of their movements (Duchowski, 2003; Poole & Ball, 2006).

Impacts and Limitations in Eye Tracking Research

Tracking eye movements provides comprehensive data on various components and measurements. For instance, eye trackers offer detailed numerical information regarding gaze duration, positioning, scanning paths, and the learner. The interpretation of collected data and measurements varies according to the research objectives and context (Poole & Ball, 2006). Consequently, the in-depth analysis of human behaviour and cognition processes benefits greatly from eye movement tracking. Alongside additional data including observer movements and verbal protocols, these findings enable researchers to deduce various insights regarding human thought and cognitive processes (Salvucci, 2000; Salvucci & Goldberg, 2000). As they simply monitor rather than interfere, eye tracking systems typically have no impact on an individual's task performance (Salvucci, 1999).

However, there are several limitations and drawbacks associated with the use of eye tracking systems, as reported by researchers. Such systems generate large data sets that are challenging and time-consuming to analyse manually or with insufficiently automated techniques (Salvucci, 1999). Poole and Ball (2006) note that researchers need to decide which components or data sets to employ when addressing their research questions. Furthermore, one of the limitations is the sensitivity of these systems. Numerous eye-tracking systems encounter difficulties in tracing the eye movements of individuals with vision impairments, particularly those who wear glasses or lenses. Such hindrances can result in the system's breakage (Poole & Ball, 2006).

Measurement of Eye Movement

The main measures used in eye tracking research are saccade (short and rapid eye movement, saccade, twitching) and fixation. Other investigated measures or metrics are gaze, scanning-fixed gaze path and blink rate. *Fixation* has been defined as "pauses in informative regions of interest" (Salvucci & Goldberg, 2000).

Research shows that there can be differing interpretations of focus data contingent upon the context or task. Fixation count or fixation duration can either reflect considerable interest in the target or imply complexity and uncertainty in comprehension of the target (Poole & Ball, 2006). Conversely, Rayner (1979) contends that human eyes tend to move unevenly over visual material or text. The gaze tracks groups of words or fields with a brief pause of approximately 0.25 seconds before shifting to the next field for another "fixation" (Rayner & Duffy, 1986). These rapid movements between fixations are referred to as "saccades".

Eye Movement and Cognition

Efforts to utilise eye movements to monitor cognitive processes in adults and infants have a lengthy history (Hayhoe, 2004). Researchers have posited that the eyes serve as windows to the mind (Salvucci, 2000; Wang, Zhai, & Su, 2001). This notion has been embraced because visual perception operates at a level beneath conscious awareness, making it a complex process. However, in natural settings, eye movements tend to be directed towards the targets of the task, even in cases where the task requires limited spatial resolution. These eye movements, which are made " without conspicuous interference" can take into account the attention mechanism, and offer valuable insights into cognitive processes (Hayhoe, 2004; Plez, Canosa, & Babcock, 2000).

Importance and Purpose

Technological developments show their effects in every field of science. Especially in the field of education, computer software has started to be integrated into teaching methods with the developing technology and because of most of these studies, it has been observed that student achievement has increased (Sezer, 1989; Akoğlu, 2003; Akçay, Tüysüz, & Feyzioğlu, 2003). In addition to these effects of technology, paper-and-pencil tests, which are relatively difficult to evaluate, can be transferred to the computer environment and tests that can be evaluated more easily with the help of technology can be created. Some of these tests are psychometric tests used to determine the cognitive characteristics of the person.
The aim of this study is to find out which regions the field dependent and field independent preservice elementary teachers focus on in their answers to the computer version of the Group Embedded Figures Test (GEFT) with the help of eye tracking device and software and to try to model them according to the cognitive styles of individuals. For this purpose, the computer version of the Group Embedded Figures Test (GEFT-C), which was previously prepared, will be used.

Method

Research Design

This study belongs to the descriptive research group since it aims to reveal the self-movements of preservice elementary teachers whose cognitive style is field dependent and field independent by using the computer version of GEFT and a modeling aim. For this descriptive study, qualitative and quantitative data were collected and analyzed. In this context, the research was conducted in qualitative and quantitative. The qualitative part of the research was structured in accordance with the document analysis approach. Document analysis is frequently used in the analysis of films, videos, visual materials and written materials containing information about the targeted phenomenon or phenomena (Yıldırım & Şimşek, 2008). The object of analysis of the research documents consisted of the eye movement data (heat map, fixed gaze plot, cluster) obtained from the preservice elementary teachers while completing the GEFT-C version. In addition, the quantitative data (time to first fixation, first fixation duration, fixation duration, total fixation duration, fixation count, visit duration, total visit duration, visit count) obtained from the eye tracking movements of the preservice elementary teachers were analyzed in accordance with quantitative research methods.

Material

The computer version of the GEFT was used in this study. The Group Embedded Figures Test (GEFT) is a test used to determine an individual's domain-dependent/domain-independent cognitive style. This test is one of the tests that measure an individual's ability to identify a particular stimulus in complex domains. The most widely used test for this purpose is the GEFT. GEFT was created by Witkin and colleagues (1971). The test consists of three parts and items that require individuals to locate and mark some simple figures on some more complex figures. The first part consists of 7 items and is administered for practice purposes. The second and third sections consist of 9 items each.

The total number of items answered correctly in the second and third sections constitutes their raw scores. Later, Witkin et al. (1977) developed a different test version. In this test, as in the first test, participants are expected to recognize and describe a simple shape Embedded in a complex framework. In the test, a sample question is first given and the participants are given one minute. At the end of this time, students are asked to examine the answer on the back of the page and compare it with their answers. They are then asked to start the test. There are 20 complex figures in the test and 20 minutes are given to complete the test. This version of the GEFT was translated and adapted into Turkish by Bahar (2003) and the internal consistency coefficient was found to be 0.80. Participants who found less than 13 correct shapes were classified as domain dependent, while those who found 13 or more correct shapes were classified as domain independent.

While preparing the GEFT-C version, all questions were scanned and transferred to the computer to adhere to the original paper-and-pencil version. Then, each scanned shape was redrawn with the Macromedia Flash program and the questions were prepared. Each question, a set of complex shapes, was programmed to allow the regions within each question to be painted by clicking. Thus, the desired shape was found by clicking on its partner in the complex structure.

The first version of the GEFT-C was administered to five preservice elementary teachers and five instructors and their opinions about the test were obtained. In addition, the test was shown to two measurement and evaluation experts and their opinions about the test were also sought. As a result of these opinions, the GEFT-C version was finalized.

On the first page of the computer version of the test, a login screen was designed where the preservice elementary teacher's ID number, gender and group were written. Then, a "Start Test" button was placed (See Figure 1).

Figure 1. Test input screen

After the preservice elementary teacher clicks on the "Start test" button, an animation about how to answer the questions appears. After watching this animation, the preservice elementary teacher can replay the animation or go to the next page (See Figure 2).

Figure 2. Information page of the test about shapes

When the "Go to Next Page" button is pressed, the preservice elementary teacher is presented with another animation introducing the interface of GEFT-C. In this animation, the preservice elementary teacher is informed that he/she can select the question number from the left side, that the "OK" button should be pressed after answering the question and that the answered questions can be checked from the bottom (See Figure 3).

Figure 3. Information page on the use of the test

After selecting the question from the left side, the preservice elamantary teacher is presented with a frame with complex shapes and the shapes that he/she needs to find in this frame. When the preservice elamantary teacher finds the shape, he/she clicks on the boxes in the frame to make the clicked box light up blue. If the clicked box is wrong, the box can be clicked again to make the box white again. When the blue boxes/lines form the shape searched for, the "OK" button must be pressed. As soon as the "OK" button is pressed, the program detects the answer to that question has been given and turns the red button at the bottom green. This way, the preservice elementary teacher can see which questions he/she has answered. If the preservice elementary teacher completes the test early and even if he/she has answered a question that he/she doubts, he/she can open the test again and give a new answer. In this case, the program deletes the old answer and replaces it with the new one (See Figure 4-a, 4-b).

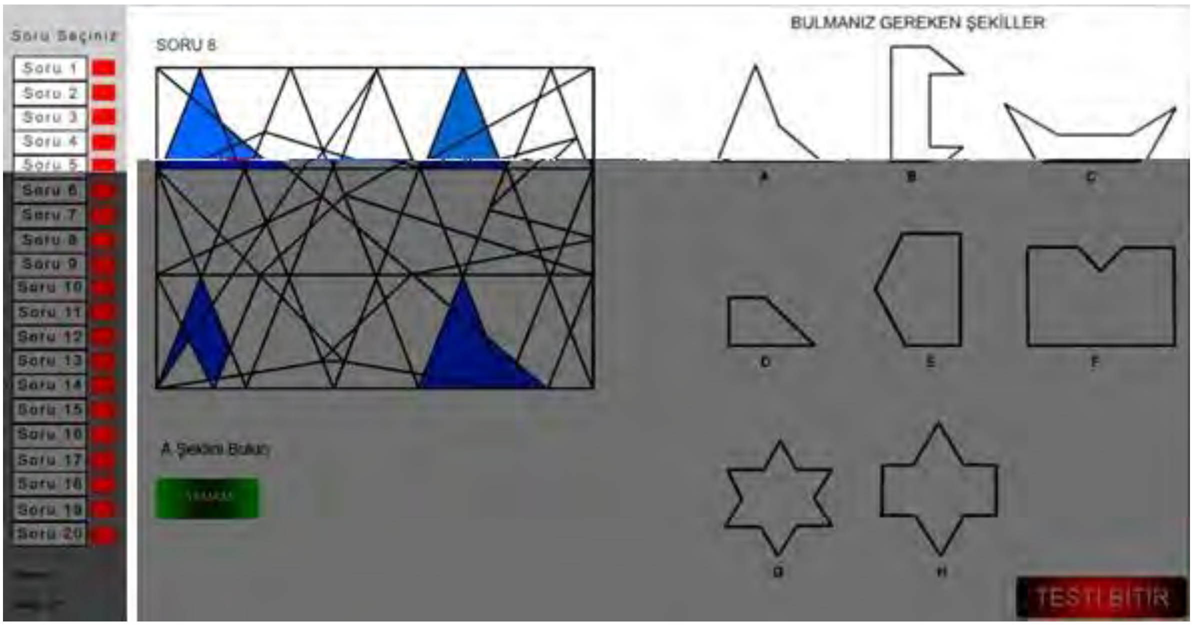


Figure 4-a. Example answer screen

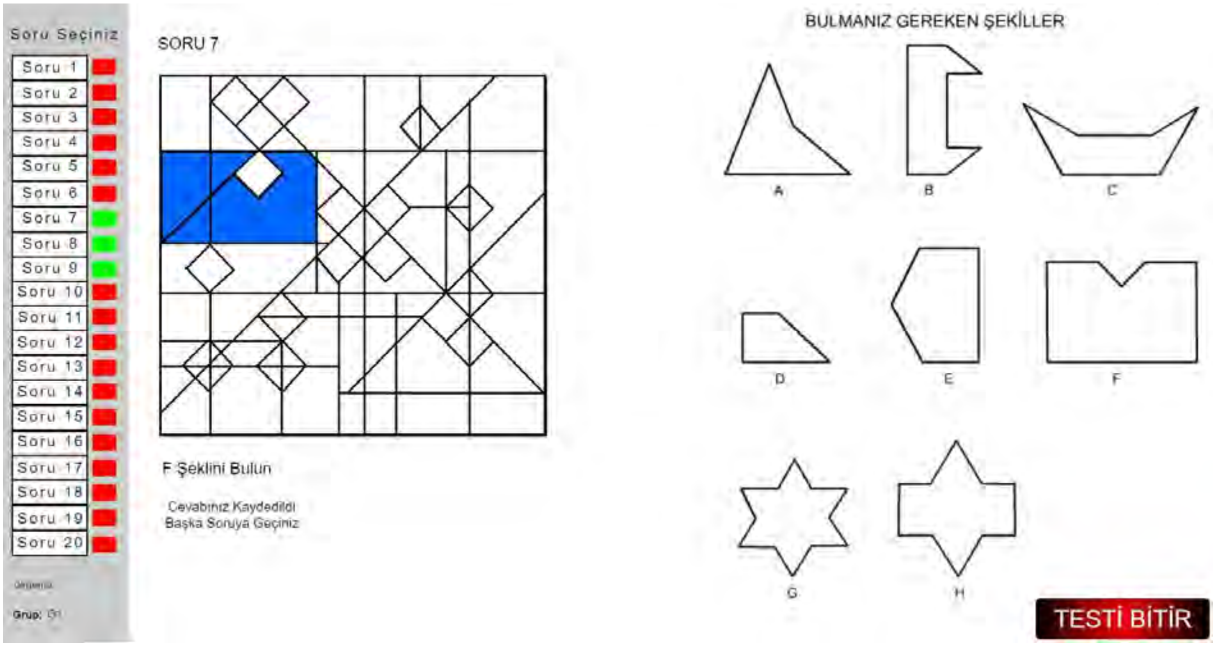


Figure 4-b. Example answer screen

After completing all the questions, the preservice elementary teacher must click the "FINISH TEST" button. After clicking the button, the program checks the answers and displays the correct answers on the screen. In addition, after the button is clicked, the program sends the 20 questions with the ID number, gender and group of the preservice elemantary teacher to the server where the program is running one by one as correct or incorrect. As a result, information about which question was answered correctly and which question was answered incorrectly for each preservice elementary teacher can be recorded on the server. Suppose the preservice elementary teacher completes 20 minutes from the beginning of the time limit. In that case, the program automatically notifies the preservice elementary teacher that the time is up and evaluates the questions done until that moment. The system also considers the questions not done as incorrect.

Participants

The study's sample selection employed a purposive sampling approach, which enables detailed information acquisition by selecting rich situations. It is a preferred method when working with one or more cases that meet specific criteria or possess particular characteristics (Büyüköztürk et al., 2012). For this reason, the study included diverse preservice primary school teachers based on cognitive style (field dependent-field independent) and gender (male-female) variables.

31 field dependent and field independent, male and female preservice elementary teachers studying at the Department of Elementary Education of a university in the Western Black Sea Region participated in the study. All participants were selected from the preservice elementary teachers attending the 3rd or 4th grade. The data obtained from 20 preservice elementary teachers, 5 "field independent" female-male with the highest score and 5 "field dependent" female-male with the lowest score, were included in the analysis process of the study. In addition, the eye tracking records obtained after the implementation of the study were examined. Since the weighted gaze sample percentage (Weighted Gaze Samples) of a field dependent male preservice elementary teacher was low (76%), the next field dependent male preservice elementary teacher was included instead. The weighted gaze sample percentages of the participants are shown in Table 1. This value indicates the amount of time the participant focuses on the screen and one or both eyes are correctly captured by the viewer and 88% was chosen as the threshold value for this study.

Table 1. Profile of participants

Participants	Gender	Cognitive Style	Correct Shape Number of	Weighted Gaze Examples (Weighted Gaze Samples) %
P1	E	FD	4	94
P2	E	FD	5	94
P3	E	FD	6	98
P4	E	FD	7	88
P5	E	FD	10	97
P6	K	FD	4	91
P7	K	FD	5	88
P8	K	FD	7	94
P9	K	FD	8	96
P10	K	FD	9	92
P11	E	FI	13	95
P12	E	FI	14	96
P13	E	FI	15	97
P14	E	FI	16	98
P15	E	FI	16	99
P16	K	FI	14	96
P17	K	FI	15	96
P18	K	FI	15	97
P19	K	FI	16	96
P20	K	FI	17	95

FD: Field dependent, FI: Field independent

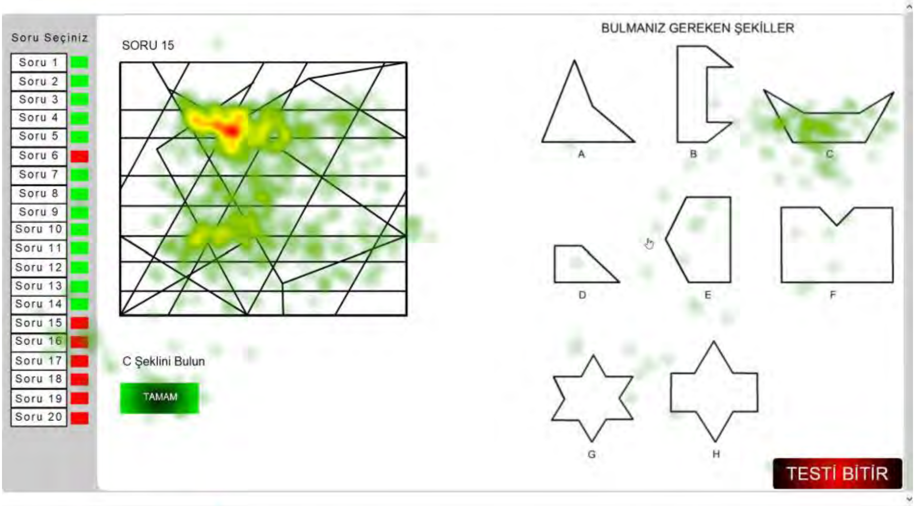
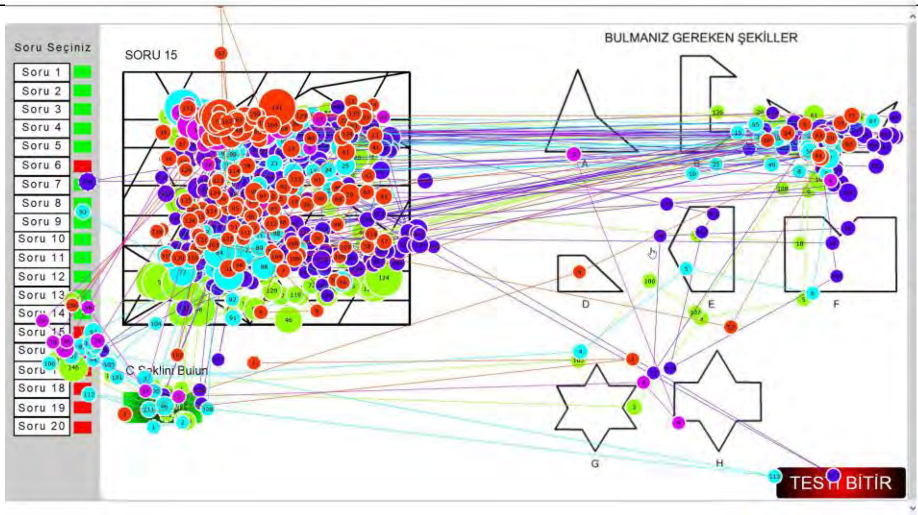
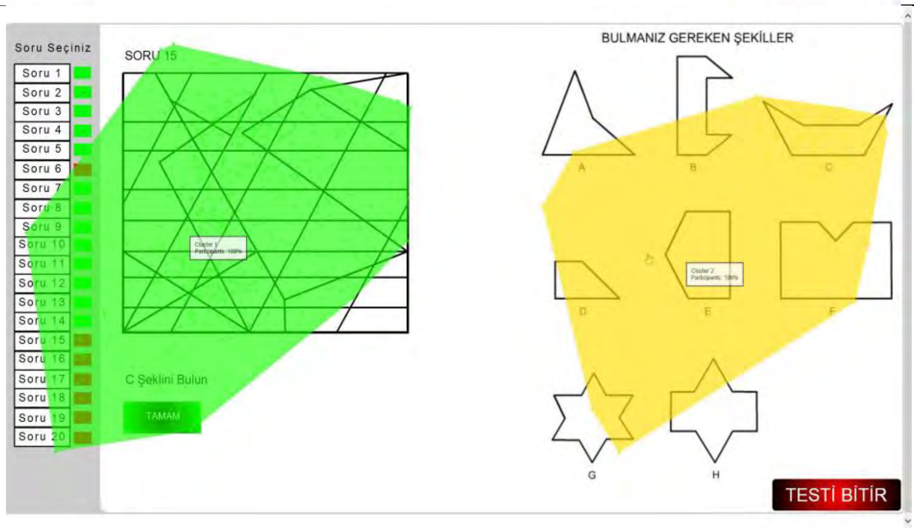
The study data were collected at the end of the spring semester in the 2017-2018 academic year. In order not to give the actual names of the preservice elementary teachers participating in the study, the codes in Table 1 were created for each preservice elementary teacher.

Data Collection Tool

Tobii X2-30 Eye Tracking device and Tobii Studio® software, which is also suitable for this equipment, were used as eye tracking tools, provided with the support provided by Bolu Abant Izzet Baysal University Scientific Research Projects unit. TOBII develops Tobii Studio® software that converts the information received from the receiver and reflective infrared cameras on the computer or monitor into visual and numerical data, saves them and provides various tools for analyzing these data later (HCI, 2014).

This software's visual data includes heat maps, gaze plots and clusters (see Table 2).

Table 2. Sample visual data obtained from Tobii Studio software

Visual Data	**Example Situation**
Heatmap	
The path of fixed gaze (Gaze plot)	
Clustering	

In addition, some numerical data can be obtained through this software and these data can be received in “.txt” format and necessary statistical calculations can be made. Some of these numerical data are listed below.

- Fixation duration
- Time to first fixation
- Visit duration
- Fixation count
- Number of observations
- Pupil diameter
- Number of saccade, etc.

Graphical representation of these numerical data can also be obtained through Tobii Studio software.

Data Collection

In this study, it was tried to determine which part of the question the preservice elementary teachers with different cognitive styles focused on and how they tried to produce solutions in the process of answering the questions in the GEFT-C version and which parts of the monitor where the figure was located while trying to find the simple shape in complex figures in the questions in the GEFT-C version. For this purpose, it was aimed to reveal which points they focused on by determining their eye movements while solving the Group Embedded Figures Test transferred to the computer environment. An eye-tracking camera was deployed on the monitor to trace the eye movements of the preservice classroom teacher. The participants were asked to remain seated in a fixed position to regularize their distance from the eye-tracking camera integrated in the monitor. To guarantee data validity and accuracy, the distance between the participant and the monitor was set at 60 cm. Since the eye tracking camera system uses a very wide field of view, which allows for tolerating quite large head movements and accurate tracking of gaze points, a 20-inch monitor was used during the implementation process. At the beginning of the session, the preservice elementary teachers were given a brief information about the procedure and the eye tracking calibration was created and recorded before the implementation started. On the first page of the test, a login screen was designed where the participant's ID number, gender and group would be written (See Figure 1). Then, a “Start Test” button was placed and after the preservice teacher clicked on the “Start Test” button, an animation about how to answer the questions appeared (See Figure 2). After watching this animation, the participant could replay the animation or go to the next page. After this animation, the participants started the test by selecting the question.

During the process of answering the questions, the eye movements of the preservice elementary teachers were examined and the eye tracking device detected the movements and created a heat map of the areas where the preservice elementary teachers focused on the monitor with the figure in the process of solving the questions. The longer the preservice teacher focused on an area, the darker the color of that area became from yellow to red. An investigation was conducted to ascertain whether a correlation exists between preservice elementary teachers' field dependent or field independent cognitive styles in answering questions and the specific areas they prioritized during the answering process.

Data Analysis

In Tobii Studio® software, the data are both statistically analyzed and one-to-one images of the eye tracking and clicking movements of the preservice elementary teachers during use are obtained. In the qualitative analysis part, content analysis of these video images was used to support the quantitative data.

Quantitative analysis process

Tobii Studio® was used to analyze the quantitative data and eye tracking statistics and eye tracking maps were obtained by this software after the eye tracking recordings of the preservice elementary teachers. With Tobii Studio software, certain areas of interest (area of interest) can be created in the regions on the screen and all data can be obtained separately in these areas of interest. An area of interest (AOI) is defined as a region within the visual stimulus where a specific area is framed and marked by the researcher and only the statistics within that area are obtained. Thus, more specific features of the visual on the screen can be analyzed rather than the entire screen (Erdemir & Yavuz, 2016). For this study, two areas of interest named “correct answer” and “shape to be seeked” were determined. Separate numerical data were obtained on these areas of interest (See Figure 5).

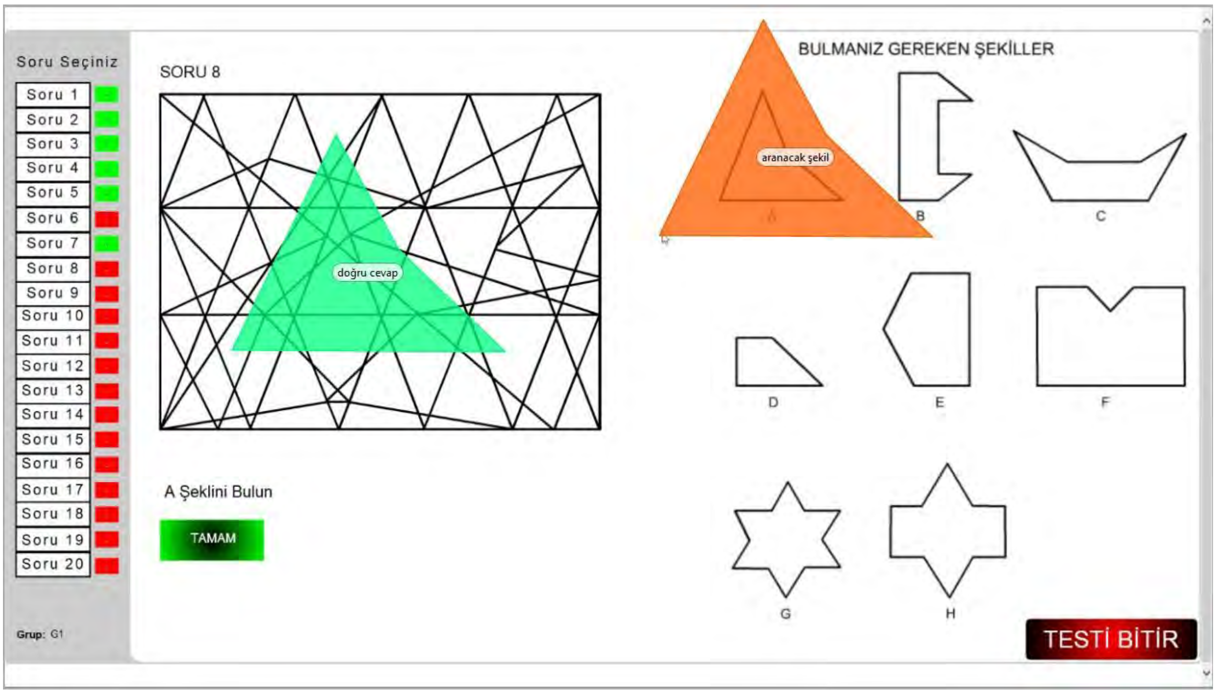


Figure 5. View of the screenshot of GEFT question 8 over the areas of interest

The variables considered in the quantitative analysis are listed as follows:

1- Fixation duration/count
2- First fixation duration
3- Time to first fixation
4- Visit duration/count

Before the analyses for these four variables, the following procedures were performed to make the results more meaningful:

1- Of these four variables, total, mean and count measurements were compared for fixation duration and visit duration and only total measurements were compared for first fixation duration and memory variables.
2- For each variable, these measurements were extracted from the data in such a way that only the regions with the shape to be seeked and the correct answer were included in the data, rather than all the parts visible on the screen.
3- The scores compared in this comparison process were organized according to whether the answers given by the individuals to the 20 items in the test were correct or incorrect. For each individual, the aforementioned scores were summed separately according to correct and incorrect answers. Then, the number of correct and incorrect answers (excluding the questions left blank) were determined. The scores collected separately were divided by the number of correct and incorrect answers and the mean values of the relevant scores were calculated for

each individual. Thus, it was aimed to prevent differences that may arise between the groups depending on the number of correct and incorrect answers.

Following the steps described above, a total of 32 measurements were obtained from the four variables analyzed. The process of obtaining these measurements can be clearly illustrated by the following diagram (See Figure 6).

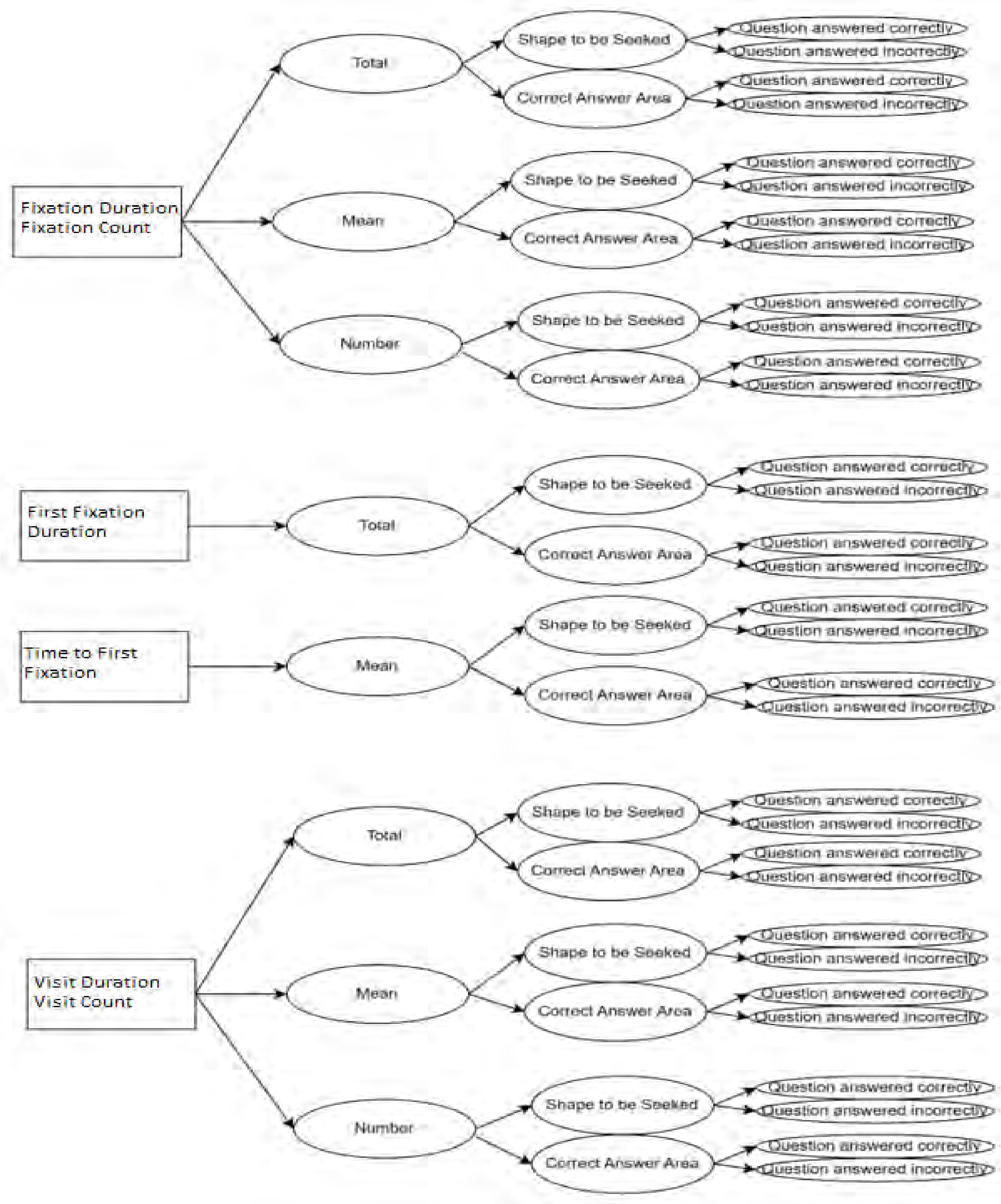


Figure 6. Representation scheme of the parameters for which measurements were obtained in quantitative analyses

Before the comparison analyses, normality examinations were first performed with the Shapiro-Wilks test for the scores compared on the basis of two subgroups. In line with the results of this examination, the tests to be used were decided.

Qualitative analysis process

The evaluation was made on the images of the eye tracking and clicking movements of the preservice elementary teachers during use obtained with Tobii Studio® software. Accordingly, using the images obtained for each preservice elementary teacher, mappings (heat map, fixed gaze plot, clustering) were made for field dependent/independent and female/male individuals (See Appendix 1, Appendix 2). Different visualizations were used for the two groups of preservice elementary teacher and the item-specific situations of each group were revealed. In addition, the number of questions that the preservice elementary teacher were able to see within the given time (20 minutes), the average time spent for each figure to be searched, the number and duration of the back and forth between the correct answer and the figure to be searched were analyzed and interpreted.

Findings and Interpretations

This research was conducted in two phases, the first part of the study was qualitative and the second part was quantitative.

Qualitative Review Findings

When the findings obtained as a result of the applications are analyzed, it is seen that most of the field dependent preservice elementary teachers (7/10) could not complete 20 questions within the given time. While the average number of questions that the field dependent preservice elementary teachers were able to see within the specified time was 16.6, the average number of correct answers was calculated as 6.5. The average time spent by the field independent preservice primary school teachers to answer all the questions was 15.9 minutes. It was determined that the field independent preservice elementary teachers were able to see all the questions within the specified time and the average number of correct answers was calculated as 15.1. When the preservice elementary teachers with field dependent and field independent cognitive styles were analyzed, it was seen that the field dependent preservice elementary teachers could not see all the questions, while the field independent preservice elementary teachers did not use all the time given. In this context, while interpreting the results, the fact that the field dependent preservice elementary teachers could not answer especially the last questions makes it difficult to interpret these questions in the context of field dependent/field independent cognitive styles.

When the answers given by the preservice primary school teachers to the questions in which they searched for the shape A are analyzed, it is seen that 0.5 of the field dependent preservice primary school teachers got it right and spent 13 seconds on average, while 5 of the field independent preservice primary school teachers got it right and spent 31.3 seconds on average. An average of 6.5 field dependent preservice primary school teachers gave incorrect answers and spent 40.9 seconds on average, while an average of 5 field independent preservice primary school teachers gave incorrect answers and spent 30.1 seconds on average (See Appendix 1-Table 14). For the questions in which the shape A was searched, it is seen that the field independent preservice elementary teachers spent more time finding the correct answer than the field dependent ones, but they gave more correct answers. In the incorrect answers, it is seen that the situation is the opposite of the situation in the questions answered correctly. This situation can be interpreted as that the field independent preservice elementary teachers spent less time on the question they could not solve than the field dependent ones.

When the questions in which preservice primary school teachers with field dependent and field independent cognitive styles searched for the shape A are analyzed, it is seen that field dependents fixated on fewer parts of the search region compared to field independents and could give only 1 correct answer. When the focus on the "Shape to be seeked" areas of interest is analyzed, it is seen that field dependents fixate on the inside of the A-shape, while field independents fixate more on the bending and breaking parts of the shape. In addition, as a result of the analysis on the "Correct Answer" area of interest, it was revealed that especially field independents fixated on the same bending and breaking parts of the shape whether the answer was correct or incorrect (See Appendix 1 - Table 14). When the heat maps of the preservice primary school teachers in the context of answering the question and gender variables are analyzed, similar results are observed (See Appendix 2 - Table 36, Table 37, Table 56 and Table 57).

When the eye movements of the preservice primary school teachers between the "Shape to be Seeked" area of interest and the "Correct Answer" area of interest were examined while answering the 8th question in which they searched for the shape A, it was observed that the field dependent female preservice primary school teachers looked at every point in the "Shape to be Seeked" area of interest, while the male preservice primary school teachers went back and forth between the inflection point and the lower part of the shape. When the answers of the field independent preservice primary school teachers were analyzed, it was found that the male preservice primary school teachers, as in the field dependent ones, made a tangent to the lower part of the shape with the inflection point, while the female preservice primary school teachers mostly made a tangent to the break point in the middle of the shape. Similar situations were observed in question 18, in which preservice primary school teachers searched for the shape A. When the areas that the preservice primary school teachers scanned while answering the questions in which they searched for the shape A are examined, it is seen that they scanned almost completely the complex drawing in which the shape is searched with the "Shape to be seeked" area of interest (See Appendix 2 - Table 36, Table 37, Table 56 and Table 57).

When the answers given by the preservice primary school teachers to the questions in which they searched for shape B are analyzed, it is seen that 1.7 of the field dependent preservice primary school teachers got it right and spent 139 seconds on average, while 6.7 of the field independent preservice primary school teachers got it right and spent 62.6 seconds on average. While 7.3 of the field dependent preservice primary school teachers gave incorrect answers and spent 83.2 seconds on average, 3.3 of the field independent preservice primary school teachers gave incorrect answers and spent 107 seconds on average (See Appendix 1 - Table 15). For the questions in which the shape B was searched, it is seen that the field independent preservice elementary teachers spent less time in finding the correct answer and gave more correct answers than the field dependent ones. In the incorrect answers, it is seen that the situation is the opposite of the situation in the questions answered correctly. This can be interpreted as that the field independent preservice elementary teachers were able to find the correct shape in the complex shape in a shorter time and the field dependent preservice elementary teachers had difficulty in finding the correct shape.

When the questions in which individuals with field dependent and field independent cognitive styles searched for the shape B were examined, it was observed that field dependents were fixated on more various regions within the search region compared to field independents and were able to give fewer correct answers to the questions. When the focus on the "Shape to be seeked" interest areas is examined, it is seen that while the field dependents are fixed inside the B-shape, the field independents are fixed more on the bending and breaking parts of the shape and their focus on the shape to be seeked is less. In addition, as a result of the examinations made on the "Correct Answer" area of interest, it was revealed that especially the field independents were fixed on the same bending and breaking parts of the shape, whether the answer was correct or incorrect (See Appendix 1 - Table 15). When the heat maps of the preservice primary school teachers in the context of answering the question and gender variables were analyzed, similar results were observed (See Appendix 2 - Table 22, Table 23, Table 40, Table 41, Table 52 and Table 53).

When the eye movements of the preservice primary school teachers between the “Shape to be Seeked” area of interest and the “Correct Answer” area of interest while answering the first question in which they searched for the shape B, it was observed that the field dependent female preservice primary school teachers looked at every point in the “Shape to be Seeked” area of interest, while the male preservice primary school teachers mostly moved to and from the bending points. When the answers of the field independent preservice primary school teachers were analyzed, it was found that males looked at every point in the “Shape to be seeked” area of interest, while females mostly moved to the break point in the middle of the shape. In the 10th question, in which the preservice primary school teachers searched for the shape B, it was observed that the field independent male preservice elementary teachers navigated to the lower part of the “Shape to be seeked” area of interest and to the bending points, while the female preservice elementary teachers navigated to the entire inner part of the shape and to the upper regions. In addition, it was observed that the preservice elementary teachers who gave the correct answer made a round-trip to the part of the complex shape that contained the correct answer, while those who gave the incorrect answer tried to find the correct answer by focusing on the whole complex shape and made more roundtrips. It can be stated that there are similar findings to the 10th question in the 16th question in which the preservice primary school teachers searched for the shape B. When the areas that the preservice primary school teachers scanned while searching for answers to the questions in which they searched for the B shape are examined, it is seen that they scanned the “Shape to be seeked” area of interest and the complex drawing in which the shape is searched almost completely. In addition, it is seen that female preservice primary school teachers scanned a wider area in both the “Shape to be seeked” area of interest and the complex drawing, while male preservice primary school teachers focused more around the desired shapes (See Appendix 2 - Table 22, Table 23, Table 40, Table 41, Table 52 and Table 53).

When the answers given by the preservice primary school teachers to the questions in which they searched for the shape C are analyzed, it is seen that 5.5 of the field dependent preservice primary school teachers got it right and spent 53.4 seconds on average, while all of the field independent preservice primary school teachers got it right and spent 53.7 seconds on average. An average of 3 field dependent preservice elementary teachers gave incorrect answers and spent an average of 85.7 seconds, while an average of 1.5 field dependent preservice elementary teachers left the question blank (See Appendix 1 - Table 16). For the questions in which the shape C was searched, it is seen that the field independent preservice elementary teachers spent less time in finding the correct answer and gave more correct answers than the field dependent ones. It can be interpreted that the field dependent preservice elementary teachers left the questions blank due to their inability to complete the questions within the given time and this may be due to the fact that the field dependent preservice elementary teachers spent more time than necessary to find the shape.

When the questions in which preservice elementary teachers with field dependent and field independent cognitive styles searched for the shape C were analyzed, it was seen that field dependent preservice elementary teachers were fixed on more various regions within the search region and gave fewer correct answers to the questions compared to field independent preservice elementary teachers. It is seen that all of the field independent preservice elementary teachers focused only on the correct shape within the complex shape and all of them gave correct answers. When the focus on the "Shape to be seeked" interest areas is examined, it is seen that while the field dependent preservice elementary teachers were fixated on the C-shape, inside and left side of the shape, the field independent preservice elementary teachers were more fixated on the bending and breaking parts of the shape and focused less on the shape to be seeked. In addition, as a result of the examinations made on the "Correct Answer" area of interest, it was revealed that field dependents fixate on the entire correct shape, while field independents fixate on the bending and breaking parts of the shape (See Appendix 1 - Table 16). When the heat maps of preservice primary school teachers taken in the context of answering the question and gender variables are analyzed, similar results are observed (See Appendix 2 - Table 38, Table 39, Table 50, Table 51).

When the eye movements of the preservice primary school teachers between the "Shape to be seeked" area of interest and the "Correct Answer" area of interest while answering the 9th question in which they searched for the shape C, it was observed that the field dependent female preservice primary school teachers looked at every point in the "Shape to be seeked" area of interest, while the male preservice primary school teachers mostly went to the bending points. When the answers of the field independent preservice primary school teachers were analyzed, it was found that in the area of interest of "Shape to be seeked", males usually went to the left side of the shape, whereas females mostly went to the upper part of the shape. In the 15th question, in which the preservice primary school teachers searched for the C-shape, unlike the 9th question, it was observed that the field independent preservice primary school teachers looked at every point in the "Shape to be seeked" area of interest, while the field dependent female preservice primary school teachers went to the whole shape and the male preservice primary school teachers went to the left side and the bending and breaking points. It is seen that the field independent preservice primary school teachers navigated to most of the complex shape, the field dependent ones who answered correctly navigated to the correct answer in the complex shape and the ones who answered incorrectly tried to find the correct answer by focusing on the whole complex shape and made more number of navigations. It was also observed that female preservice primary school teachers scanned a wider area in both the "Shape to be seeked" area of interest and the complex drawing, while male preservice primary school teachers focused more on the area around the desired shapes (See Appendix 2 - Table 38, Table 39, Table 50, Table 51).

When the answers given by the preservice primary school teachers to the questions in which they searched for the shape D are analyzed, it is seen that 5 of the field dependent preservice primary school teachers got it right and spent 43.5 seconds on average, while 9 of the field independent preservice primary school teachers got it right and spent 29.3 seconds on average. An average of 3.3 of the field dependent preservice elementary teachers gave incorrect answers and spent an average of 67 seconds, while an average of 1 of the field independent preservice elementary teachers gave incorrect answers and spent an average of 32.3 seconds. It can be stated that an average of 1.7 of the field dependent preservice elementary teachers left the question about the D shape blank and it can be stated that the question left blank was the 17th question due to the unbalanced use of time (See Appendix 1 - Table 17). It is seen that the field independent preservice elementary teachers spent less time in finding the correct answer and gave more correct answers than the field dependent ones. In the incorrect answers, it is seen that the situation is the opposite of the situation in the questions answered correctly. This situation can be interpreted as that field independents can find the shape in the correct answer in less time and field dependents have difficulty in finding the shape. In addition, considering that the complexity level of the D shape is lower compared to other shapes, it can be stated that it is expected that the time averages for the questions related to the D shape are lower compared to other shapes.

When the questions in which preservice primary school teachers with field dependent and field independent cognitive styles searched for the shape D were analyzed, it was observed that field dependents were more fixed in various regions within the search region and could give fewer correct answers to the questions compared to field independents. It was observed that this situation was the opposite of the situation described above in question 17. It can be said that such a situation emerged due to the fact that half of the field dependent preservice elementary teachers did not answer this question. When the focus on the "Shape to be seeked" interest areas is examined, it is seen that while field dependent and field independent students were fixed in the shape of D, field independent students focused less on the shape to be seeked. In addition, as a result of the examinations made on the “Correct Answer” interest area, it was revealed that field independents were fixed on the bending and breaking parts of the shape, while field dependents were fixed in a way to scan the entire shape (See Appendix 1 - Table 17). When the heat maps of the preservice primary school teachers taken in the context of answering the question and gender variables were analyzed, similar results were observed (See Appendix 2 - Table 24, Table 25, Table 42, Table 43, Table 54 and Table 55).

When the eye movements of the preservice primary school teachers between the “Shape to be Seeked” area of interest and the “Correct Answer” area of interest were examined while answering the second question in which they searched for the D shape, it was observed that the field dependent preservice primary school teachers looked at every point in the “Shape to be Seeked” area of interest and they mostly moved to and from the bending points of the “Correct Answer” area of interest. When the answers of the field independent preservice elementary teachers were analyzed, it was found that males looked at every point in the “Shape to be seeked” area of interest and made more back and forth, while females made more back and forth to the breaking points of the shape. In the 11th question, in which the preservice primary school teachers searched for the D shape, unlike the 2nd question, it was observed that field dependent preservice primary school teachers navigated to all regions of the “Correct Answer” area of interest and field independent female preservice primary school teachers navigated more between the “Correct Answer” area of interest and the “shape to be seeked” area of interest compared to male preservice primary school teachers. In the 17th question, in which the preservice primary school teachers searched for the D-shape, it was observed that field dependent and field independent preservice primary school teachers looked at the points of fracture and bending in the “Shape to be seeked” area of interest and field independent male preservice primary school teachers made more back and forth than female preservice primary school teachers. When the areas that the preservice primary school teachers scanned while searching for answers to the questions in which they searched for the D-shape were examined, it was seen that they scanned the “Shape to be seeked” area of interest and the complex drawing in which the shape was searched almost completely. In addition, female preservice primary school teachers scanned a wider area in both the “Shape to be seeked” area of interest and the complex drawing, while male preservice primary school teachers focused more around the desired shapes (See Appendix 2 - Table 24, Table 25, Table 42, Table 43, Table 43, Table 54 and Table 55).

When the answers given by the preservice primary school teachers to the questions in which they searched for the shape E are analyzed, it is seen that 2.7 of the field dependent preservice primary school teachers got it right and spent 62.3 seconds on average, while 6 of the field independent preservice primary school teachers got it right and spent 42.1 seconds on average. On average, 5.3 preservice elementary teachers with field dependence gave incorrect responses and took 73.9 seconds to answer. In comparison, 4 preservice elementary teachers with field independence gave incorrect replies and took 36.9 seconds. On average, two preservice elementary teachers who were field dependent left the 19th question about the E shape unanswered due to unbalanced time usage during the test (refer to Table 18 in Appendix 1). It was observed that the field independent preservice elementary teachers required less time to locate the correct answer and provided more accurate responses compared to their field dependent counterparts for the E shape related questions. In the incorrect responses, a contrasting outcome was documented compared to the correct answers. This result suggests that preservice elementary teachers, who demonstrate independence in their field, can identify the shape in the correct answer in lesser time, whereas those who show dependence on their field encounter challenges in identifying the shape.

When analyzing the questions answered by preservice elementary teachers of field dependent and field independent cognitive styles who searched for the E shape, it became apparent that field dependents focused on different areas within the search region and provided fewer accurate responses to the questions than field independents. Upon analysis of the interest areas for the 'Shape to be seeked', it is revealed that field dependents concentrate mainly on the refraction and bending points, whereas field independents view the complete E shape with significantly lower focus. Furthermore, the analysis of the "Correct Answer" interest area exposed that the field independents focused on the bending and breaking components of the shape, whereas the field dependents fixated on the shape in its entirety (Refer to Appendix 1 - Table 18). Upon analyzing the heat maps of preservice elementary teachers in relation to gender and question variables, comparable results were discovered (refer to Appendix 2 - Tables 28-31, 58 and 59).

As the participants attempted to locate the shape "E" in the fourth question, their eye movements were tracked between the "Shape to be Sought" and "Correct Answer" areas of interest. It was observed that female preservice elementary teachers, who were field dependent, alternated their gaze between the inner section and the points of refraction inflection in the areas of interest labeled "Shape to be Seeked" and "Correct Answer." In contrast, male preservice elementary teachers who were also field dependent alternated their gaze between the points of refraction inflection and the upper section. Similar results were observed in preservice elementary teachers who were field independent, although there were fewer occurrences of go-arounds. Moreover, it was noted that female trainee primary school teachers completed more rounds compared to their male counterparts. In the fifth query, where trainees searched for the shape E, it was apparent that, unlike the fourth query, female trainees who exhibited both field dependent and field independent learning styles focused on the left area of interest in the "Shape to be seeked" section. During the 19th question, when preservice elementary teachers were tasked with finding the shape E, it was noted that field dependent and field independent preservice elementary teachers focused their attention on the areas of fracture and bending in the "Shape to be seeked" region of interest, which differed from their approach during the fourth question. Technical term abbreviations will be explained upon first use. The paper will adhere to standard citation and footnote formatting and maintain objective language throughout. The structure will be clear and concise with logical progression and causal connections between statements. No bias or subjective evaluations will be included and grammatical correctness will be ensured. Spelling and vocabulary will align with British English conventions. Upon analysis of the areas scanned by preservice elementary teachers during their search for answers to questions about Shape E, it is apparent that they thoroughly scanned the "Shape to be seeked" area of interest as well as the complex drawing in which the shape was being sought. Biased evaluations have been excluded and technical term abbreviations have been defined for clarity. The language used is clear, concise and objective, with a formal register and precise word choice. The text is free from grammatical errors, adheres to conventional academic structure and citation guidelines and displays a clear logical progression with causal connections between statements. There is an absence of filler words and emotional or figurative language. Furthermore, preservice female elementary teachers exhibited a broader scanning pattern for both the "Shape to be seeked" area of interest and the complex drawing, while their male counterparts placed more emphasis on the desired shapes (refer to Appendix 2 - Table 28, Table 29, Table 30, Table 31, Table 58 and Table 59).

Upon analysing the responses provided by preservice elementary teachers regarding the identification of shape F, it was observed that 3.5 of the field dependent preservice elementary teachers answered correctly, while spending an average of 60.7 seconds. On the other hand, 7.5 of the field independent preservice elementary teachers answered correctly, spending an average of 44.7 seconds. On average, 3.5 field dependent preservice elementary teachers provided incorrect responses and took 70.4 seconds, whereas 2.5 field independent preservice elementary teachers made erroneous responses, taking an average of 102.4 seconds. On average, three field dependent preservice elementary teachers left the question on the F-shape blank. This question was the 20th and left unanswered due to an unbalanced use of time (refer to Appendix 1, Table 19). Field independent preservice elementary teachers who provided correct answers for questions involving the F-shape performed better than their field dependent peers, taking less time and achieving a higher number of correct answers. This can be interpreted as field independents being able to quickly identify the shape in the correct answer and field dependents struggling to do so. In cases where field independents are unable to find the correct answer, they spend a long time searching.

Upon analysing the questions pertaining to preservice elementary teachers with field dependent and field independent cognitive styles searching for the F-shape, it was observed that field dependent preservice elementary teachers fixated on different regions within the search area and provided fewer correct answers as compared to their field independent counterparts. Upon analysing the "Shape to be seeked" and "Correct Answer" points of interest, it is evident that both field dependent and field independent preservice elementary teachers placed their attention on the refraction-bending points situated at the top, rather than on the shape itself. This is illustrated in Appendix 1 - Table 19. When analyzing the heat maps of preservice elementary teachers in relation to the question and gender variables, comparable outcomes can be seen (refer to Appendix 2, Table 34, Table 35, Table 60 and Table 61).

Meanwhile, during their response to the 7th question where they looked for the F-shape, the eye movements of the preservice elementary teachers between the "Shape to be Seeked" area of interest and the "Correct Answer" area of interest were observed. The study found that female preservice elementary teachers, who were field dependent, tended to focus on the inner and left fracture inflection points in the "Shape to be Seeked" and "Correct Answer" areas of interest. In contrast, male preservice elementary teachers, who were also field dependent, showed a preference for the inner and upper fracture inflection points. It can be stated that the preservice elementary teachers with a field independent disposition travelled in a round-trip pattern towards the left and upper inflection points of refraction, although fewer roundtrips were observed. The same pattern of results was found when preservice elementary teachers searched for the F-shape in the 20th question. Upon examination of the scanned areas during the preservice elementary teachers' search for the F shape, it becomes evident that they focused on the "Shape to be seeked" area of interest and scanned the complex drawing in which the shape is searched almost entirely. Additionally, it was observed that female preservice elementary teachers scanned a wider region in both the "Shape to be seeked" area of interest and the complex drawing, whereas male preservice elementary teachers concentrated more on the surrounding area of the desired shapes (consult Appendix 2 - Table 34, Table 35, Table 60 and Table 61).

Upon analysis of the responses given by preservice elementary teachers when searching for shape G, it was found that 2.5% of field dependent preservice elementary teachers answered correctly and on average spent 57.8 seconds, whereas 9.5% of field independent preservice elementary teachers answered correctly and spent an average of 34.7 seconds. On average, 6.5 field dependent preservice elementary teachers gave incorrect answers and spent 60.7 seconds, while 0.5 field independent preservice elementary teachers gave incorrect answers and spent 32 seconds (refer to Table 20 in Appendix 1). It has been observed that preservice primary school teachers who demonstrate field independence and provide correct answers to G-shaped questions, are able to locate the given shape more quickly and accurately than their field-dependent peers. This implies that individuals who possess field-independent traits are likely to have superior shape-locating abilities. When examining the queries presented to individuals with field dependent and field independent cognitive styles who were searching for the letter G, it was noted that both field dependent and field independent individuals fixated on the corresponding areas within the search region. Additionally, it was found that field dependent individuals provided fewer correct answers to the questions compared to field independent individuals. When analyzing the areas of interest, "Shape to be seeked" and "Correct Answer", it can be concluded that preservice elementary teachers, both field dependent and field independent, concentrated on the shape's interior, as well as the points of refraction and bending. They displayed a greater focus on the shape in comparison to other shapes (refer to Appendix 1 - Table 20). This may be due to the numerous breaking and bending points found within the shape. When analyzing the heat maps of preservice elementary teachers in the context of the question and gender variables, comparable outcomes are evident (refer to Appendix 2 - Table 44, Table 45, Table 46 and Table 47).

During the 12th question, when preservice elementary teachers were searching for the G-shape, their eye movements were analyzed. It was observed that female preservice elementary teachers who were field dependent tended to focus on both the "Shape to be Seeked" and "Correct Answer" areas, whereas field dependent male preservice elementary teachers tended to focus on the refraction and inflection points. It can be argued that the preservice elementary teachers, who displayed field independent tendencies, engaged in a comprehensive examination of the entire shape through a back-and-forth approach. In the 13th item, which involved searching for the G-shape, participants carefully navigated the "Shape to be seeked" area of interest, taking into account the breaking and bending points, as well as the full extent of the "Correct Answer" area. Upon analyzing the areas scanned by preservice elementary teachers when searching for the G shape, it was found that they thoroughly scanned the "Shape to be seeked" area of interest and the intricate drawing containing the shape (refer to Appendix 2 - Tables 44, 45, 46 and 47). There was almost complete coverage of the complex drawing during the search.

Upon analysis of the responses from preservice elementary teachers searching for shape H, it is evident that 4.3 of the field dependent participants answered correctly, averaging 69.3 seconds. Conversely, 7.3 of the field independent participants answered correctly with an average of 49.6 seconds. While 4.7% of the preservice elementary teachers who exhibited field dependence gave incorrect responses and took an average of 98.8 seconds, 2.7% of those who displayed field independence gave incorrect responses and took an average of 61.5 seconds (refer to Table 21 in Appendix 1). For the queries where shape H was sought, it is evident that primary school preservice elementary teachers who were field independent spent less time locating the correct response and had a higher count of accurate replies compared to their field dependent counterparts. Conversely, when incorrect responses were given, the opposite scenario was noted for answered questions. This can be interpreted as field independent preservice elementary teachers being able to identify the shape in the correct answer faster, while field dependent preservice elementary teachers struggle to find the shape.

When analyzing the questions in which preservice elementary teachers with field dependent and field independent cognitive styles conducted their search for the H-shape, it became evident that both field dependent and field independent preservice elementary teachers were fixated on particular regions within the search area. When analyzing the "Shape to be Seeked" interest areas, it appears that preservice elementary teachers tend to concentrate on the topics of refraction and bending, whereas the emphasis of field independents is somewhat lower. The evaluation is carried out in an objective and clear manner and technical abbreviations are explained upon first use. Regular formatting and citation style are maintained to adhere to academic conventions, while language is kept formal and neutral, devoid of jargon and colloquialism and precise words are chosen for subject-specific vocabulary. Furthermore, logical progression is ensured with causal connections between statements and grammatical correctness is ensured without any errors in spelling or punctuation. On the flip side, the analysis of the "Correct Answer" section disclosed that preservice elementary teachers who were either field dependent or field independent were inclined to concentrate on the inner part of the shape and the curvature and fragmentation of the shape (refer to Appendix 1 - Table 21).

Upon analysis of the heat maps of preservice elementary teachers in relation to answering questions and gender variables, comparable outcomes were identified (refer to Appendix 2 - Table 26, Table 27, Table 32, Table 33, Table 48 and Table 49).

During the third question, the gaze of female preservice elementary teachers with field dependent cognitive styles were recorded as they searched for shape H. Results revealed a tendency to concentrate on refraction and bending points located on the left side of the "Shape to be Seeked" area of interest, between which and the "Correct Answer" area of interest their eye movements travelled. While male preservice elementary teachers who were field dependent focused on the overall shape, their field dependent counterparts moved back and forth between the entire "Correct Answer" area of interest. Abbreviations were explained when first used and technical language was used consistently throughout. Additionally, the text adhered to common academic section formatting and maintained a formal register. Although fewer back-and-forth were observed in the Field Independent preservice elementary teachers, they were observed to move back-and-forth between the refraction and bending points on the left side of the "Shape to be seeked" area of interest and the area covering the entire "Correct Answer" section. Technical tests were conducted to substantiate these findings. Similar results were found in the sixth question, where preservice elementary teachers were searching for the H shape, although there were more tangents present. In question 14, in contrast to question 6, it was observed that male preservice elementary teachers who are field dependent focused on the bending and breaking points of the "Shape to be seeked" area of interest, whereas female preservice elementary teachers who are field dependent focused on the whole shape. Field dependent preservice elementary teachers shifted their attention between the area that covers all of the "Correct Answer" areas of interest. In contrast, field independent preservice elementary teachers exhibited similarities with field dependent male preservice elementary teachers. Analysis of the scanned areas during the search for the H-shaped figure in question revealed that the preservice elementary teachers covered almost the entire area of interest for the "shape to be seeked" and the intricate diagram containing the shape. Refer to Appendix 2 - Table 26, Table 27, Table 32, Table 33, Table 48 and Table 49 for further details.

Upon a holistic analysis of the responses provided by preservice elementary teachers, it is evident that they encounter difficulties in identifying shapes with high fracture-bending points. Furthermore, field dependent preservice elementary teachers require more time in comparison to their field independent counterparts to locate the appropriate shape. It appears that the preservice elementary teachers who were field independent could provide more accurate responses within the allotted time. Specifically, they concentrated on the refraction-bending points within the areas of interest, namely the "Shape to be Seeked" and "Correct Answer" zones and exhibited fewer movements back and forth between said areas compared to field dependent preservice elementary teachers. Additionally, it was observed that the preservice elementary teachers thoroughly scanned the areas of interest labeled "Shape to be Sought" and "Correct Answer," ensuring complete inclusion.

The second part of the study presents the quantitative results.

Quantitative Review Findings

This section presents the results of the quantitative comparison of the field dependent and field independent measures of preservice elementary teachers. First, the results of the normality analysis, which was carried out to decide on the type of analysis, are presented. The results of the normality analysis are presented in Table 3.

Table 3. Shapiro Wilks Normality test results

Variable	Category	Response Status	Group	Statistics	N	p	Category	Response Status	Group	Statistics	N	p
FIXATION DURATION-FIXATION COUNT	Shape to be seeked - Total	Correct	FD	.868	10	.094	Correct Answer - Total	Correct	FD	.868	10	.094
			FI	.955	10	.730			FI	.938	10	.533
		Incorrect	FD	.783	10	0.009*		Incorrect	FD	.910	10	.280
			FI	.899	10	.213			FI	.900	10	.219
	Shape to be seeked – Mean	Correct	FD	.939	10	.544	Correct Answer - Mean	Correct	FD	.913	10	.302
			FI	.951	10	.683			FI	.883	10	.142
		Incorrect	FD	.914	10	.312		Incorrect	FD	.946	10	.623
			FI	.934	10	.485			FI	.956	10	.735
	Shape to be seeked - Count	Correct	FD	.910	10	.280	Correct Answer - Count	Correct	FD	.952	10	.687
			FI	.948	10	.648			FI	.901	10	.223
		Incorrect	FD	.898	10	.207		Incorrect	FD	.927	10	.418
			FI	.955	10	.730			FI	.849	10	.057
FIRST FIXATION DURATION	Shape to be seeked - Total	Correct	FD	.789	10	0.011*	Correct Answer - Total	Correct	FD	.946	10	.622
			FI	.930	10	.448			FI	.951	10	.676
		Incorrect	FD	.922	10	.374		Incorrect	FD	.924	10	.389
			FI	.938	10	.534			FI	.878	10	.125
TIME TO FIRST FIXATION	Shape to be seeked - Total	Correct	FD	.918	10	.340	Correct Answer - Total	Correct	FD	.772	10	0.007*
			FI	.609	10	0.000*			FI	.965	10	.843
		Incorrect	FD	.917	10	.331		Incorrect	FD	.859	10	.074
			FI	.653	10	0.000*			FI	.890	10	.169
VISIT DURATION-VISIT COUNT	Shape to be seeked - Total	Correct	FD	.859	10	.075	Correct Answer - Total	Correct	FD	.888	10	.159
			FI	.953	10	.709			FI	.964	10	.831
		Incorrect	FD	.805	10	0.017*		Incorrect	FD	.898	10	.211
			FI	.900	10	.218			FI	.915	10	.316
	Shape to be seeked – Mean	Correct	FD	.933	10	.478	Correct Answer - Mean	Correct	FD	.672	10	0.000*
			FI	.925	10	.398			FI	.931	10	.459
		Incorrect	FD	.938	10	.527		Incorrect	FD	.931	10	.460
			FI	.942	10	.579			FI	.964	10	.829
	Shape to be seeked - Count	Correct	FD	.922	10	.371	Correct Answer - Count	Correct	FD	.804	10	0.016*
			FI	.947	10	.629			FI	.943	10	.584
		Incorrect	FD	.855	10	.066		Incorrect	FD	.977	10	.945
			FI	.932	10	.469			FI	.951	10	.685

*p<0.05 (Score that differs significantly from the normal distribution)

In accordance with the results of the Shapiro-Wilks test for comparing the measures obtained from the subject specific and non-subject specific preservice elementary teachers, it was decided whether the type of analysis would be parametric or non-parametric. The Mann-Whitney U test, one of the nonparametric tests, was preferred for the measures with a significance level below 0.05 in one or both subgroups in the analyses, in other words with a distribution that differs significantly from the normal distribution. For measurements that were not significantly different from the normal distribution, the unpaired samples t-test was used. These two tests make it possible to compare data from two different subgroups. In analyses performed with the Mann-Whitney U test, the median was calculated for the subgroups and the arithmetic mean was calculated for the unpaired samples T test due to the possibility of a skewed distribution. The significance level was set at 0.05 for all analyses. The significance level calculated for differences between measures at the subgroup level was reported as a significant difference for measures with a significance level below 0.05. Comparison analyses for the subgroups are shown in Table 4.

Table 4. Comparison analysis results of field dependent and independent groups

Variable	Group	N	Arithmetic mean	S	df	t	p
Fix.Dur._STS_QAC_Total	FD	10	3.856	2.227	18.000	2.145	0.046*
	FI	10	2.222	0.921			
Fix.Dur._ CAnsA._QAC_Total	FD	10	22.742	10.794	11.017	2.179	.052
	FI	10	14.893	3.636			
Fix.Dur._CAnsA._QAIc_Total	FD	10	20.494	6.613	18.000	2.268	0.036*
	FI	10	13.290	7.557			
Fix.Dur._STS_QAC_Mean	FD	10	0.196	0.037	18.000	0.126	.901
	FI	10	0.193	0.048			
Fix.Dur._CAnsA_QAC_Mean	FD	10	0.416	0.143	18.000	-0.459	.651
	FI	10	0.450	0.185			
Fix.Dur._STS_QAIc_Mean	FD	10	0.203	0.036	18.000	0.547	.591
	FI	10	0.194	0.043			
Fix.Dur._CAnsA_QAIc_Mean	FD	10	0.377	0.081	18.000	0.705	.490
	FI	10	0.344	0.123			
Fix.Dur._STS_QAC_Count	FD	10	18.304	7.922	11.181	2.922	0.014*
	FI	10	10.546	2.778			
Fix.Dur._CAnsA_QAC_Count	FD	10	55.357	22.450	18.000	2.176	0.043*
	FI	10	37.686	12.464			
Fix.Dur._STS_QAIc_Count	FD	10	26.144	14.321	11.395	2.773	0.018*
	FI	10	12.762	5.272			
Fix.Dur._CAnsA_QAIc_Count	FD	10	52.554	20.593	18.000	1.709	.105
	FI	10	35.601	23.660			

First Fix.Dur._CAnsA_QAC_Total	FD	10	0.258	0.066	18.000	-0.564	.580
	FI	10	0.280	0.105			
FirstFix.Dur._STS_QAIc_Total	FD	10	0.193	0.030	18.000	2.832	0.011*
	FI	10	0.148	0.040			
FirstFix.Dur._CAnsA_QAIc_Total	FD	10	0.240	0.047	18.000	1.295	.212
	FI	10	0.197	0.094			
TFF_CAnsA_QAIc_Total	FD	10	3.157	1.772	18.000	-0.863	.399
	FI	10	4.175	3.282			
Vis.Dur._STS_QAC_Count	FD	10	10.192	3.693	18.000	3.245	0.004*
	FI	10	6.071	1.578			
Vis.Dur._STS_QAIc_Count	FD	10	13.868	7.493	11.632	2.555	0.026*
	FI	10	7.376	2.897			
Vis.Dur._CAnsA_QAIc_Count	FD	10	16.443	4.854	18.000	3.770	0.001*
	FI	10	9.122	3.761			
Vis.Dur._STS_QAC_Mean	FD	10	0.403	0.129	18.000	0.810	.428
	FI	10	0.362	0.092			
Vis.Dur._CAnsA_QAC_Mean	FD	10	2.088	0.996	18.000	0.266	.793
	FI	10	1.997	0.438			
Vis.Dur._STS_QAIc_Mean	FD	10	0.451	0.142	18.000	1.295	.212
	FI	10	0.379	0.104			
Vis.Dur._CAnsA_QAIc_Mean	FD	10	1.260	0.201	12.147	-0.729	.480
	FI	10	1.378	0.473			
Vis.Dur._STS_QAC_Total	FD	10	4.349	2.498	11.694	2.223	0.047*
	FI	10	2.464	0.978			
Vis.Dur._CAnsA_QAC_Total	FD	10	25.489	11.087	10.428	2.216	.050
	FI	10	17.417	3.133			
Vis.Dur._CAnsA_QAIc_Total	FD	10	22.990	7.817	18.000	1.946	.067
	FI	10	15.803	8.679			
Fix.Dur._STS_QAIc_Total	FD	10	5.500	13.600	136	19	0.019*
	FI	10	2.356	7.400	74		
FirstFix.Dur._STS_QAC_Total	FD	10	0.164	10.500	105	50	1.000
	FI	10	0.183	10.500	105		
TFF_STS_QAC_Total	FD	10	2.469	11.100	111	44	0.650
	FI	10	1.797	9.900	99		
TFF_CAnsA_QAC_Total	FD	10	4.175	12.000	120	35	0.257
	FI	10	3.755	9.000	90		
TFF_STS_QAIc_Total	FD	10	1.891	9.800	98	43	0.597
	FI	10	2.063	11.200	112		
Vis.Dur._CAnsA_QAC_Count	FD	10	11.938	13.100	131	24	0.049*
	FI	10	9.431	7.900	79		
Vis.Dur._STS_QAIc_Total	FD	10	6.098	13.500	135	20	0.023*
	FI	10	2.533	7.500	75		

*$p<0.05$

To make the results understandable, each of the measures that were found to be significantly different is presented separately for three of the four variables that show a significant difference.

For the Fixation time variable:

For the fixation duration variable, the measurements for which a significant difference was found when comparing the field dependent and field independent groups are listed below:

1- Based on the results of an unpaired t-test performed on the total number of measurements for participants who accurately searched the shape area, a significant difference of 1.635 seconds was observed in favour of the field dependent group; t(18) =2.145, p=0.046, p<0.05.

According to this result, it can be argued that the fixation durations of the field dependent preservice elementary teachers in the Shape area to be seeked in the questions they got right were higher than those of the field independent preservice elementary teachers.

2- According to the results of the independent samples t-test carried out at the level of the total measurement for the correct answer area, it was found that there was a significant difference of 7.204 seconds in favour of the field dependent group; t(18) =2.268, p=0.036, p<0.05.

According to this result, it can be interpreted that the field dependent preservice elementary teachers were fixated in the correct answer area for a longer time than the field independent preservice elementary teachers.

3- According to the results of the independent samples t-test performed on the unit level measurements of those who correctly made the Shape area to be seeked, it was determined that there was a significant difference of 7.758 units in favour of the field dependent group; t(11,181) =2.922, p=0.014, p<0.05.

According to this result, it can be argued that the field dependent preservice elementary teachers realised fixation by going to the Shape area to be seeked more often than the field independent preservice elementary teachers in the questions they got right.

4- According to the results of the independent samples t-test performed on the unit level measurements for the correct answer region, it was found that there was a significant difference of 17.671 units in favour of the field dependent group; t(18) =2.176, p=0.043, p<0.05.

According to this result, it can be argued that the field dependent preservice elementary teachers made fixations by going to the correct answer region more often than the field independent preservice elementary teachers in the questions they got right.

5- According to the results of the independent samples t-test performed on the measurements of the Shape area to be seeked and the count level of those who made an error, it was found that there was a significant difference of 13.381 units in favour of the field dependent group; t(18) =2.773, p=0.018, p<0.05.

According to this result, it can be interpreted that the field dependent preservice elementary teachers made more fixations by going to the Shape area to be seeked more often than the field independent preservice elementary teachers.

6- According to the results of the Mann-Whitney U-test performed at the total measurement level for the Shape area to be seeked, there was a significant difference of 3.144 seconds (median) in favour of the field dependent group; U=19.000, p=0.019, $p<0.05$.

According to this result, it can be argued that the fixation durations in the Shape area to be seeked in the questions that the field dependent preservice elementary teachers got wrong were higher than those of the field independent preservice elementary teachers.

For the first fixation duration variable:

For the first variable, fixation duration, there is only one measurement for which a significant difference was found when comparing the field dependent and field independent groups. The results for this measurement were as follows:

1- According to the results of the independent samples t-test performed at the level of the whole measurement for the Shape area to be seeked, there was a significant difference of 0.045 seconds in favour of the field dependent group; t(18) =2.832, p=0.011, $p<0.05$.

According to this result, it can be argued that the time to first fixation of the field dependent preservice elementary teachers on the Shape area to be seeked is significantly higher than that of the field independent preservice elementary teachers in the questions they got wrong.

For the visit duration variable:

For the visit duration variable, the measurements for which a significant difference was found in the comparison between the area-dependent and area-independent groups are listed below:

1- According to the results of the independent samples t-test carried out on the measurements of the count level for those who correctly made the Shape area to be seeked, it was determined that there was a significant difference of 4.121 units in favour of the area-dependent group; t(18) =3.245, p=0.004, $p<0.05$.

According to this result, it can be argued that the visit count to the Shape area to be seeked is significantly higher in the questions that the field dependent preservice elementary teachers got right than in the questions that the field independent preservice elementary teachers got right.

2- According to the results of the independent samples t-test carried out on the measurements of the Shape area to be seeked and the count level for the wrong doers, it was found that there

was a significant difference of 6.492 units in favour of the field dependent group; t(11,632) =2.555, p=0.026, p<0.05.
According to this result, it can be interpreted that the field dependent preservice elementary teachers visited the Shape area to be seeked for in the questions they got wrong significantly more often than the field independent preservice elementary teachers.
3- According to the results of the independent samples t-test carried out in the correct answer area, it was found that there was a significant difference of 7.321 units in favour of the field dependent group; t(18) =3.770, p=0.001, p<0.05.
According to this result, it can be argued that field dependent preservice elementary teachers made a significantly higher visit count to the correct answer region than field independent preservice elementary teachers.
4- According to the results of the independent samples t-test carried out at the level of the total measurement for those who correctly visited the shape area, it was found that there was a significant difference of 1.885 seconds in favour of the field dependent group; t(11,694) =2.223, p=0.047, p<0.05.
According to this result, it can be argued that the visit durations to the Shape area to be seeked is significantly higher in the questions that the field dependent preservice elementary teachers got right than in the questions that the field independent preservice elementary teachers got right.
5- According to the results of the Mann-Whitney U-test carried out in the area of correct answers, the measurements of the count level of those who got it right, it was found that there was a significant difference of 2.507 units (median) in favour of the field dependent group; U=24.000, p=0.049, p<0.05.
According to this result it can be interpreted that field dependent preservice elementary teachers made a significantly higher visit count to the correct answer region than field independent preservice elementary teachers in the questions they got correct.
6- According to the results of the Mann-Whitney U-test carried out at the level of the total measurement for the Shape area to be seeked, there was a significant difference of 3.566 seconds (median) in favour of the field dependent group; U=20.000, p=0.023, p<.05.
According to this result, it can be argued that the visit durations to the Shape area to be seeked is significantly higher for the questions in which the field dependent preservice elementary teachers made mistakes than for the field independent preservice elementary teachers.

Discriminant Analysis Results

Following the analyses, a discriminant analysis was performed to determine the extent to which the variables that were found to be significantly different between the field dependent and field independent groups correctly separated these two groups.

Testing Assumptions

Before carrying out the discriminant analyses, the following assumptions were checked for the variables considered:

1- Multivariate normality: The assumption of multivariate normality was tested using the square of the Mahalonobis distances and the inverse cumulative Chi-square values calculated for the variables. For two or more multivariate distributions, the variables are said to be multivariate if the scatter plot of the ordered distances forms a straight line (Alpar, 2011). The scatterplot drawn for the assumption of multivariate normality is shown in Figure 7.

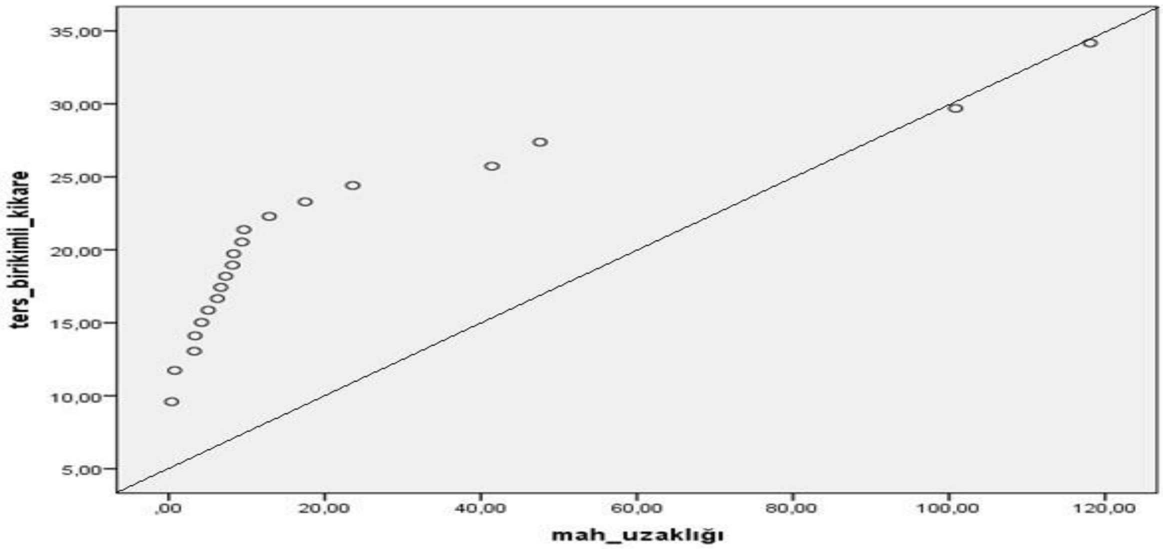


Figure 7. Multivariate normality check scatter diagram

When analyzing the scatter plot, it can be interpreted that the points are clustered on a single line. This result indicates that multivariate normality is guaranteed.

2- Multicollinearity: No variable ought to be a linear combination of other discriminating variables, whereby a linear combination constitutes a weighted sum of one or more variables multiplied by constant coefficients. If there is a high correlation between any of the discriminant variables and another discriminant variable, or if one variable is a function of the others, the tolerance value for this variable will approach 0 and this will prevent some calculations from being performed. Due to high compatibility between two variables in the analysis, the discriminant function coefficients are unable to accurately establish the relative significance of the discriminant variables (Alpar, 2011). In other words, multicollinearity is the situation where items are highly correlated with each other in pairs and singularity is the situation where these correlations are equal to 1 (Tabachnick & Fidell, 2007). Since a variable to be obtained as a linear combination does not contain any new information beyond the information that the components have, its use is unnecessary. In this direction, firstly, the correlation coefficients between the independent variables were examined to determine the independent variables to be included in the discriminant analysis. Correlations between variables are given in Table 5.

Table 5. Correlation coefficients between discriminant variables

No	Variable name	1	2	3	4	5	6	7	8	9	10	11	12	13
1	Fix.Dur._STS_QAC_Total		0.362	0.928	0.095	0.669	0.301	0.833	0.598	0.135	0.991	0.522	0.722	0.713
2	Fix.Dur._CAnsA_QAIc_Total	0.362		0.505	0.386	0.710	0.390	0.475	0.663	0.791	0.395	0.453	0.678	0.665
3	Fix.Dur._STS_QAC_Count	0.928	0.505		0.254	0.820	0.423	0.937	0.756	0.387	0.949	0.639	0.836	0.821
4	Fix.Dur._CAnsA_QAC_Count	0.095	0.386	0.254		0.165	0.206	0.295	0.144	0.606	0.153	0.740	0.128	0.122
5	Fix.Dur._STS_QAIc_Count	0.669	0.710	0.820	0.165		0.477	0.827	0.958	0.596	0.696	0.463	0.983	0.977
6	FirstFix.Dur._STS_QAIc_Total	0.301	0.390	0.423	0.206	0.477		0.450	0.309	0.362	0.330	0.158	0.533	0.547
7	Vis.Dur._STS_QAC_Count	0.833	0.475	0.937	0.295	0.827	0.450		0.773	0.443	0.859	0.663	0.824	0.820
8	Vis.Dur._STS_QAIc_Count	0.598	0.663	0.756	0.144	0.958	0.309	0.773		0.582	0.614	0.505	0.913	0.910
9	Vis.Dur._CAnsA_QAIc_Count	0.135	0.791	0.387	0.606	0.596	0.362	0.443	0.582		0.203	0.513	0.517	0.508
10	Vis.Dur._STS_QAC_Total	0.991	0.395	0.949	0.153	0.696	0.330	0.859	0.614	0.203		0.558	0.744	0.732
11	Fix.Dur._STS_QAIc_Total	0.522	0.453	0.639	0.740	0.463	0.158	0.663	0.505	0.513	0.558		0.420	0.408
12	Vis.Dur._CAnsA_QAC_Count	0.722	0.678	0.836	0.128	0.983	0.533	0.824	0.913	0.517	0.744	0.420		0.997
13	Vis.Dur._STS_QAIc_Total	0.713	0.665	0.821	0.122	0.977	0.547	0.820	0.910	0.508	0.732	0.408	0.997	

When the results in Table 5 are examined, the relationship levels of the 13 variables planned to be included in the discriminant analysis were calculated using the Spearman Rho correlation coefficient. According to the results obtained, it was determined that all the relationships between the variables were significant ($p<0.05$). In addition, the cells with pairs of variables showing a relationship above 0.70 are shown in the table with different intonation. In line with these results, it was decided to continue the analysis by selecting four variables from among the 13 variables to avoid the problem of multicollinearity. While these four variables are highly correlated with some of the remaining nine variables, they are not highly correlated within themselves.

To confirm the absence of multicollinearity among the four variables, CI (condition index), VIF (variance inflation ratios) and tolerance values were examined. It can be said that there is no multicollinearity if the CI value of the variables is below 30, the VIF value is less than 10 or the tolerance values are .10 or above (Hair anderson, Tahtam, & Black, 1998). The values obtained for multicollinearity analysis are presented in Table 6.

Table 6. Multicollinearity statistics

Model		Multi-link statistics	
		Tolerance	VIF
1	2.	0.602	1.662
	3.	0.542	1.845
	4.	0.707	1.415
	6.	0.794	1.259
a. Dependent Variable: ordinal no			
Model		Self-value	Condition Index
		4.694	1.000
		0.123	6.177
		0.089	7.253
		0.068	8.339
		0.026	13.508

According to the results obtained, it is concluded that there is no multicollinearity problem.

3- Homogeneity of Covariances: Box's M test was used to check whether the assumption of homogeneity of covariances, which is one of the important assumptions of Discriminant Analysis, is met. The hypotheses we tested here are as follows:

Ho : Covariance matrices of groups are equal.

H1 : Covariance matrices of groups are not equal.

The test is sensitive to multiple departures from normality and tends to indicate that matrices are not equal when the normality assumption is violated. The test is based on the determinant of group covariance matrices. If the number of samples in the groups is large, the group covariance matrices may not differ much from each other, but the probability of significance may be small. This test is sensitive to departures from multivariate normal distribution. For the linear discriminant function to be optimal and minimize the probability of misclassification, each group should be a sample drawn from a multivariate normal population and the covariance matrices of all groups should be equal.

As can be seen in the table below, the null hypothesis cannot be rejected at $\alpha<0.05$ significance level. In other words, the groups are equal in terms of covariance matrices. Thus, what is necessary for the application of discriminant analysis is seen. Box's M test results are presented in Table 7.

Table 7. Box's M Test results

Box's M		23.753
F	Approx.	1.793
	df1	10.000
	df2	1549.004
	Sig. (p)	0.057

According to the results in Table 7, the assumption of homogeneity of covariance was confirmed, M(10,000;1549,004)=23.753, p=0.057, p>0.050.

Discriminant Analysis Process

After testing the assumptions, the results of the discriminant analysis are shared in a stepwise manner.

Assessing the Importance of Separation Functions

Equality of Group Means

Wilks' Lambda and F test are used to test the equality of group means. The F results in this table are used to determine whether the independent variables of interest have a significant variability in classification decisions and which variable is important in classification (Güzeller & Kelecioğlu, 2006). The Wilks' Lambda statistic obtained here is a value related to the variables and the smaller it is, the more the variable contributes to the discriminant function. Wilks' Lambda takes a value between 0 and 1 and **λ**=0 means that the group means are different, **λ** =1 means that the group means are similar, that is, there is no distinction between the groups (Garson, 2008). The results of this test are presented in Table 8.

Table 8. Test of equality of group means

	Wilks' Lambda	F	df1	df2	p
Fix.Dur._ CAnsA_QAIc_Total	0.778	50.146	1	18	0.036*
Fix.Dur._STS_QAC_Count	0.678	80.540	1	18	0.009*
Fix.Dur._ CAnsA_QAC_Count	0.792	40.736	1	18	0.043*
FirstFix.Dur._STS_ QAIc_Total	0.692	80.018	1	18	0.011*

**p<0.05*

According to the results in Table 8, it is seen that there is a significant difference between the field dependent and field independent variable groups for all four variables. Accordingly, it was concluded that the four variables were effective in group distinction.

Eigenvalue - Wilk's Lambda - Natural Correlation

To determine how important the discriminant function is, we look at the natural correlation, eigenvalue and Wilks' Lambda statistics.

The natural correlation measures the correlation between discriminant scores and groups and indicates the total variance explained. In Table 9, this value is 0.690. In order to interpret this value, it needs to be squared (0.476). Accordingly, the model can explain 48% of the variance in the dependent variable.

Eigenvalues are statistics used to evaluate how important discriminant analysis is. When the eigenvalue takes the value zero, it means that the discriminant analysis does not have any discriminant properties. The larger the eigenvalue statistic, the more of the variance in the dependent variable will be explained by that function. Although it is not a precise value, eigenvalues greater than 0.40 are considered perfect (Kalaycı, 2010). In this example, since the eigenvalue statistic is 0.909, we can argue that this function provides a good discrimination. Table 9 evaluates the significance of the discriminant functions.

Table 9. Eigenvalue

Function	Self-value	Variance Percentage	Cumulative Percentage	Canonical Correlation
1	0.909	100.000	100.000	0.690

In the next table, Table 10, the Wilks' Lambda statistic shows the fraction of the total variance in the separation scores that cannot be explained by the differences between groups. In this model, 52% of the total variance in discrimination scores cannot be explained by differences between groups. In addition, the Wilks' Lambda value here tests the significance of the eigenvalue statistic for each discriminant function. In this model, there is 1 discriminant function and it is significant.

Table 10. Wilks Lambda

Function	Wilks' Lambda	Chi-Square	sd	p
1	0.524	10.349	4	0.035*

$*p<0.05$

Evaluation of the Importance of Independent Variables in Discriminant Analysis

To assess the importance of the independent variables, it is necessary to look at the discriminant function coefficients and the loadings of each variable in the structure matrix. Standardized discriminant function coefficients show the partial importance of independent variables in the estimation of each dependent variable, in other words, the unique contribution of each variable to the discriminant function. In this sense, they correspond to beta coefficients in regression analysis (Kalaycı, 2010).

The results obtained to determine the order of importance of the independent variables are given in Table 11. As can be seen in these results, all variables are important discriminating independent variables in grouping. The reason for using standardized coefficients here is to eliminate the effects of different means and different standard deviations in the independent variables. Otherwise, variables with smaller standard deviations may have larger discrimination coefficients. In this case, it becomes difficult to assess the relative importance of the independent variables. In addition, large numbers indicate a large contribution, while small numbers indicate a low contribution. The sign of the coefficient has no special meaning.

Table 11. Standardized Canonical Correlation Coefficients for independent variables

	Function
	1
Fix.Dur._ CAnsA_QAIc_Total	.162
Fix.Dur._STS_QAC_Count	.468
Fix.Dur._CAnsA_QAC_Count	.293
First Fix.Dur._STS_QAIc_Total	.590

According to the results obtained, the order of importance of independent variables in the separation process is from highest to lowest:

1- FirstFix.Dur._STS_ QAIc _Total
2- Fix.Dur._STS_QAC_Count
3- Fix.Dur._CAnsA_QAC__Count
4- Fix.Dur._CAnsA_QAIc_Total

Discriminant Function

The discriminant function is a linear combination of independent variables. Mathematical description of the function:

$Z = \alpha + b_1 x_1 + b_2 x_2$ is in the form of.

Where Z is the discrimination score, is a constant, b's are discriminant coefficients and x's are independent variables. This equation is similar to multiple regression. However, here b's maximize the distance between the means of the independent variables (Kalaycı, 2010). Table 12 shows the unstandardized discriminant coefficients.

Table 12. Canonical Discriminant Coefficients

	Function
	1
Fix.Dur._CAnsA_QAIc_Total	.023
Fix.Dur._STS_QAC_Count	.079
Fix.Dur._CAnsA_QAC_Count	.016
First Fix.Dur._STS_QAIc_Total	16.640
Constant	-5.109

The separation function equation written through the coefficients of the Canonical Separation Function is as follows:

$Z= -5.109 + 0.023\chi_1 + 0.079\chi_2 + 0.016\chi_3 + 16.640\chi_4$

Evaluating the Success of Discriminant Analysis

Table 13 shows the table statistics obtained as a result of discriminant analysis.

Table 13. Discriminant analysis results

	GROUP	Prior probabilities of group membership		Total
		FD	FI	
Calculation	FD	8	2	10
	FI	1	9	10
%	FD	80.0	20.0	100.0
	FI	10.0	90.0	100.0

In discriminant analysis, the success of the analysis is the percentage of correct classification. The higher the percentage of correct classification, the more successful the analysis is. When Table 13 is analyzed, 8 out of 10 field dependent participants were correctly predicted. While 9 out of 10 field independent preservice elementary teachers were correctly predicted, 1 was misclassified. In percentage terms, 80% of the field dependent preservice elementary teachers were correctly classified, while 90% of the field independent ones were correctly classified and 10% were misclassified.

In summary, it was determined that there was a significant difference in 13 of the 32 variables measured in the analyzes. Among these 13 variables, it was decided that it would be appropriate to use four of them in discriminant analysis after checking the assumptions. According to the results of discriminant analysis with four variables, it was concluded that these variables could successfully separate preservice elementary teachers as field dependent and independent. In other words, these variables, which were measured through eye tracking technology, can be used to make a meaningful modeling in terms of whether preservice elementary teachers are field dependent or not.

Conclusions and Recommendations

As a result of the findings obtained from the qualitative part of the research, it was found that preservice elementary teachers generally had difficulty in finding the shapes with more breaking-bending points, field dependent preservice elementary teachers spent more time than field independent preservice elementary teachers in finding the correct shape and field independent preservice elementary teachers were able to give more correct answers within the given time, It was observed that field independent preservice primary school teachers focused more on the refraction and inflection points of the “Shape to be seeked” and “Correct Answer” interest areas and made less back and forth between the “Shape to be seeked” and “Correct Answer” interest areas compared to field dependent preservice primary school teachers. The cluster data obtained with the eye tracking device and software showed that the preservice elementary teachers generally scanned all of the “Shape to be seeked” and “Correct Answer” interest areas on the screen with their eyes.

When quantitative data are analyzed as a result of the analyzes, it was determined that there was a significant difference in 13 of the 32 variables measured. In the comparison analyses, all of the variables measured were grouped under four main headings. These four main headings are “Fixation duration/count”, “First fixation duration”, “Time to first fixation” and “Visit duration/count”. It was determined that there was a statistically significant difference between field dependent and field independent preservice elementary teachers for 13 of the 32 variables collected under these four main headings. The 13 variables are under 3 of the four main headings (“Fixation duration/count”, “First fixation duration” and “visit duration/count”). These 13 variables are listed as follows according to their subheadings.

Fixation duration/count:

1. The Shape area to be seeked, at the total measurement level for those who get it right
2. Correct answer area, total measurement level for those who got it wrong
3. The Shape area to be seeked for, in count level measurements for those who do it correctly
4. Correct answer area, count level measurements for those who got it right
5. Shape area to be seeked, count level measurements for those who do wrong
6. Shape area to be seeked, total measurement level for wrongdoers

First fixation duration

7. Shape area to be seeked, total measurement level for wrongdoers

Visit duration

8. The Shape area to be seeked, count level measurements for those who do it correctly
9. Shape area to be seeked, count level measurements for those who do wrong
10. Correct answer area, count level measurements for those who did wrong

11. The shape area to be seeked, at the total measurement level for those who get it right
12. Correct answer area, count level measurements for those who do it correctly
13. Shape area to be seeked, total measurement level for wrong doers

In line with the significant differences obtained from the variables under the subheading of fixation duration/count, it can be argued that field dependent preservice primary school teachers fixate by going to the correct answer region more times than field independent students in the questions they get right. In addition, it can be interpreted that field dependent preservice elementary teachers fixate by going to the Shape area to be seeked more times than field independent students in the incorrect questions. Finally, according to these results, it can be inferred that the fixation durations in the Shape area to be seeked in the incorrect questions of the field dependent preservice elementary teachers are more than the field independent preservice elementary teachers.

The results obtained for the time to first fixation subheading indicate that the time to first fixation of the field dependent preservice primary school teachers to the Shape area to be seeked is significantly higher than the field independent preservice primary school teachers in the questions they got wrong.

According to the results obtained for the last main heading, visit duration/count, which includes the variables for which there is a significant difference, it is possible to interpret that the visit count to the Shape area to be seeked is significantly higher in the questions that the field dependent preservice primary school teachers made correctly than the field independent preservice primary school teachers. In addition, according to the results obtained, it can be argued that field dependent preservice primary school teachers made a significantly higher visit count to the Shape area to be seeked than field independent preservice primary school teachers in the questions they got wrong. Again, according to the other results obtained for this title, it was deemed appropriate to infer that field dependent preservice primary school teachers visited the correct answer region at a significantly higher level than field independent preservice primary school teachers in the questions they got wrong. In addition to these, according to the results, it can be interpreted that the visit durations to the Shape area to be seeked is significantly higher in the questions that the field dependent preservice primary school teachers got right than the field independent preservice primary school teachers. In addition, the analyses conducted for the variables under this heading indicate that the field dependent preservice elementary teachers made significantly higher visits to the correct answer region than the field independent preservice elementary teachers in the questions they got correct.

Finally, the results of the analyses show that the visit durations to the shape area to be seeked is significantly higher in the questions in which the field dependent preservice elementary teachers made mistakes compared to the field independent preservice elementary teachers.

In the analyses in which field dependent and field independent preservice elementary teachers were compared, it was decided that four of the 13 variables that were determined to have a significant difference between these two groups would be appropriate to be used in discriminant analysis after checking the assumptions. These four variables are as follows:

1. Shape area to be seeked, total measurement for wrongdoers
2. The shape area to be seeked for, in count level measurements for those who do it correctly
3. Correct answer area, count level measurements for those who got it right
4. Correct answer area, total measurement level for incorrect answers

In the discriminant analysis performed with four variables, it was concluded that these four variables correctly classified 80% of the field dependent preservice elementary teachers and 90% of the field independent ones. These results indicate that these variables can successfully classify preservice elementary teachers as field dependent and independent. In other words, these variables measured through eye tracking technology can be used to make a meaningful modeling in terms of whether preservice elementary teachers are field dependent or not.

In line with the results obtained from this study, it is seen that eye tracking technology works quite well for modeling preservice elementary teachers in the context of their cognitive styles. From this point of view, especially in areas such as physics, mathematics, geometry where it is important to understand visuals such as physics, mathematics, geometry, etc., where preservice elementary teachers have difficulty, which parts they focus on, etc. These results can be used to facilitate learning. With the inclusion of brain data such as FMRI, EEG, etc. in this study, information such as which lobes and parts of the brain are working and active in the process of determining cognitive styles can be obtained and the brain activities of the participants will support the findings obtained with eye movements.

In future studies, different results can be obtained by increasing the number of participants. The sample of the study consists of preservice elementary teachers. In future studies, studies can be conducted on different preservice elementary teachers and the effect of verbal, equal weight, numerical groups on eye tracking measurements can be examined in determining cognitive styles. Again, in future studies, studies can be conducted on the modeling of different psychometric properties such as cognitive styles through eye tracking technology.

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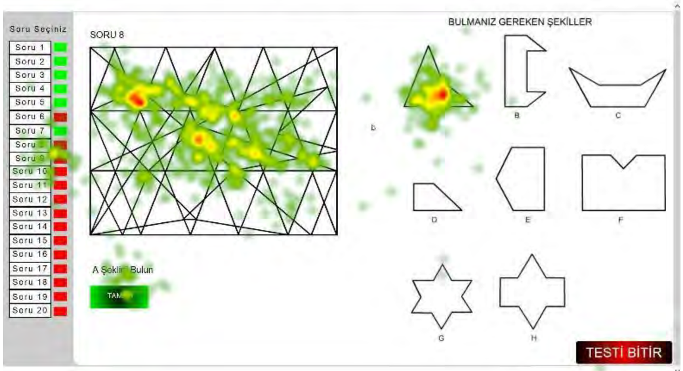
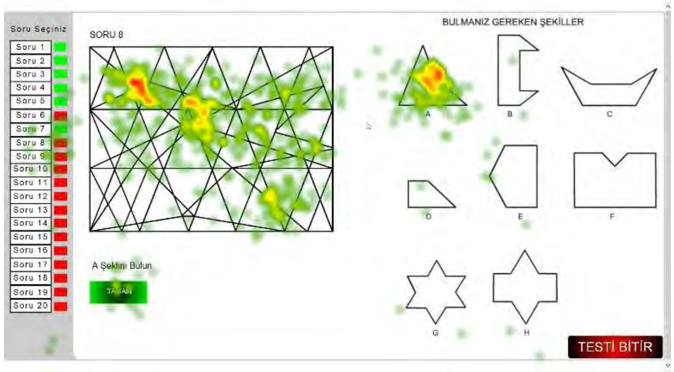
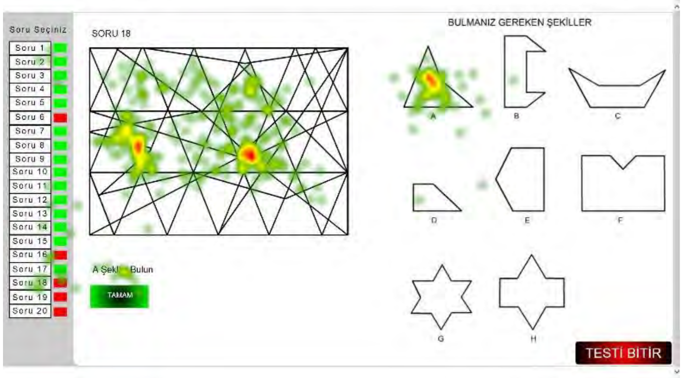
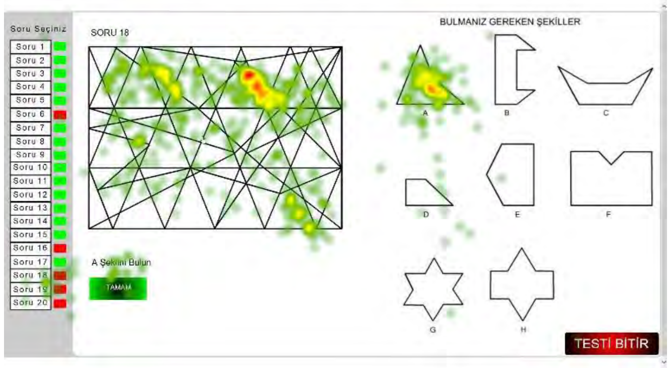
APPENDIX 1

Heat maps for shapes in GEFT

Table 14. Heat maps of preservice elementary teachers in form A

	Field Dependent (n=10)					Field Independent (n=10)				
S8										
	R= 0	W= 10	B= 0	X_{ds}= 0	X_{ys}= 36.8	R= 2	W= 8	B= 0	X_{ds}= 38	X_{ys}= 30
S18										
	R= 1	W= 3	B= 6	X_{ds}= 13	X_{ys}= 54.7	R= 8	W= 2	B= 0	X_{ds}= 29.6	X_{ys}= 31.5
X_A	X_{Ad}= 0.5	X_{Ay}= 6.5	X_{Ab}= 3	X_{Ads}= 13	X_{Ays}= 40.9	X_{Ad}= 5	X_{Ay}= 5	X_{Ab}= 0	X_{Ads}= 31.3	X_{Ays}= 30.1

** R: Number of correct answers;*

W: Number of incorrect answers;

B: Number of questions left blank;

Xds: Average time (seconds) spent by those who answered the question correctly;

Xys: Average time (seconds) spent by those who answered the question correctly;

XAd: Average of the number of correct answers given for shape A;

XAy: Average number of incorrect answers given for shape A;

XAb: Average of the number of questions left blank for form A;

XAds: Average time (seconds) spent by those who answered the questions of form A correctly;

XAys: Average time (seconds) spent by those who answered the questions of form A incorrectly.

Table 15. Heat maps of preservice elementary teachers in form B

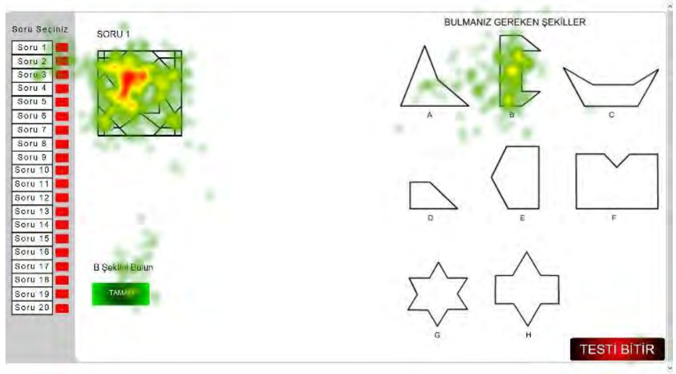
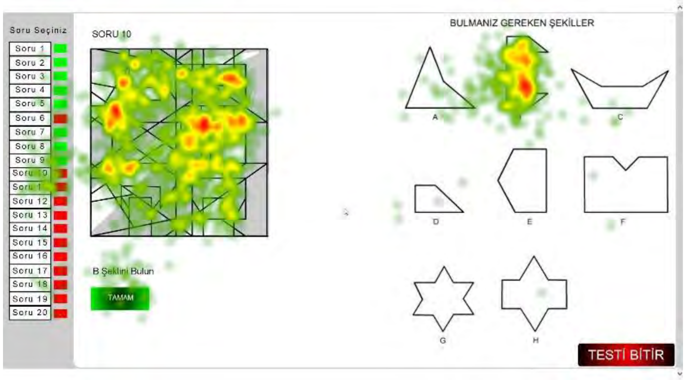
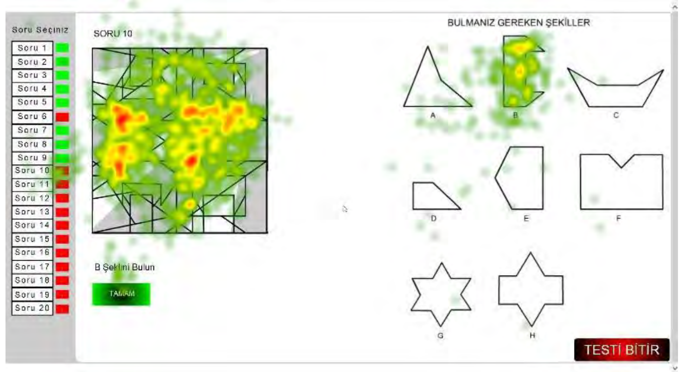
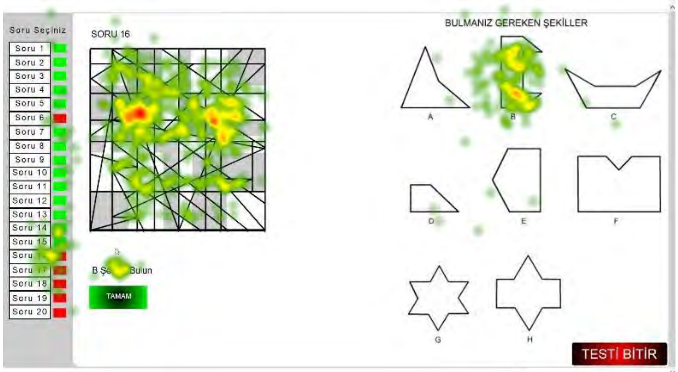
	Field Dependent (n=10)					**Field Independent (n=10)**				
S1										
	R= 3	W= 7	B= 0	X_{ds}= 196	X_{ys}= 103	R= 9	W= 1	B= 0	X_{ds}= 31.2	X_{ys}= 56
S10										
	R= 1	W= 9	B= 0	X_{ds}= 79	X_{ys}= 85.7	R= 3	W= 7	B= 0	X_{ds}= 67.7	X_{ys}= 90
S16										
	R= 1	W= 6	B= 3	X_{ds}= 28	X_{ys}= 56.3	R= 8	W= 2	B= 0	X_{ds}= 96	X_{ys}= 192
X_B	X_{Bd}= 1.7	X_{By}= 7.3	X_{Bb}= 1	X_{Bds}= 139	X_{Bys}= 83.2	X_{Bd}= 6.7	X_{By}= 3.3	X_{Bb}= 0	X_{Bds}= 62.6	X_{Bys}= 107

Table 16. Heat maps of preservice elementary teachers in form C

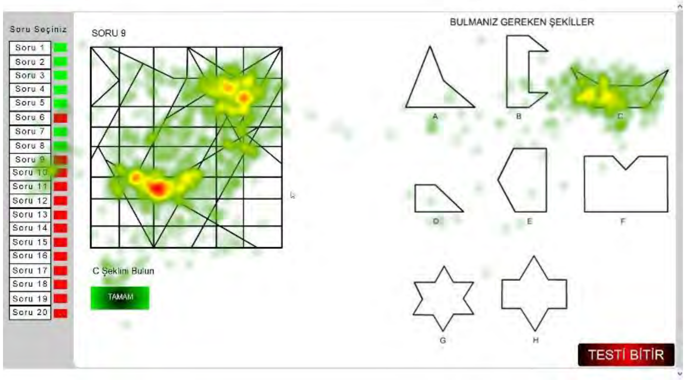
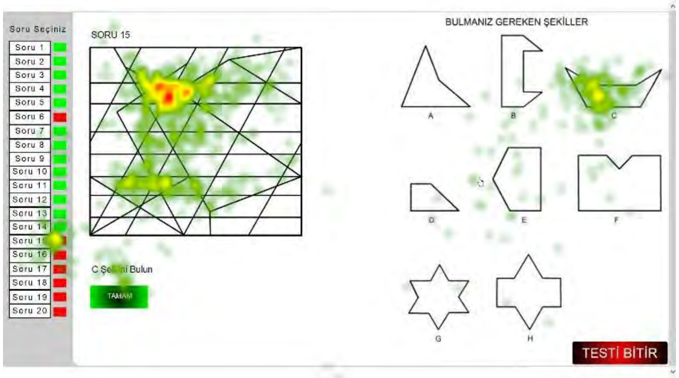
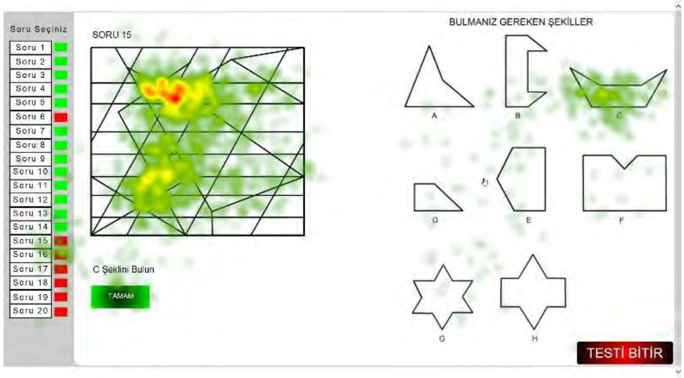
<table>
<tr><td></td><td colspan="5">Field Dependent (n=10)</td><td colspan="5">Field Independent (n=10)</td></tr>
<tr><td rowspan="2">S9</td><td colspan="5">
</td><td colspan="5">
</td></tr>
<tr><td>R= 8</td><td>W= 2</td><td>B= 0</td><td>X_{ds}= 59.3</td><td>X_{ys}= 91</td><td>R= 10</td><td>W= 0</td><td>B= 0</td><td>X_{ds}= 29.2</td><td>X_{ys}= 0</td></tr>
<tr><td rowspan="2">S15</td><td colspan="5">
</td><td colspan="5">
</td></tr>
<tr><td>R= 3</td><td>W= 4</td><td>B= 3</td><td>X_{ds}= 37.7</td><td>X_{ys}= 83</td><td>R= 10</td><td>W= 0</td><td>B= 0</td><td>X_{ds}= 78.2</td><td>X_{ys}= 0</td></tr>
<tr><td>X_C</td><td>X_{Cd}= 5.5</td><td>X_{Cy}= 3</td><td>X_{Cb}= 1.5</td><td>X_{Cds}= 53.4</td><td>X_{Cys}= 85.7</td><td>X_{Cd}= 10</td><td>X_{Cy}= 0</td><td>X_{Cb}= 0</td><td>X_{Cds}= 53.7</td><td>X_{Cys}= 0</td></tr>
</table>

Table 17. Heat maps of preservice elementary teachers in form R

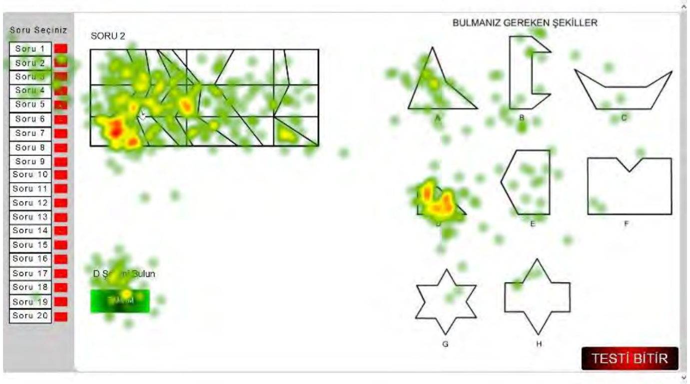
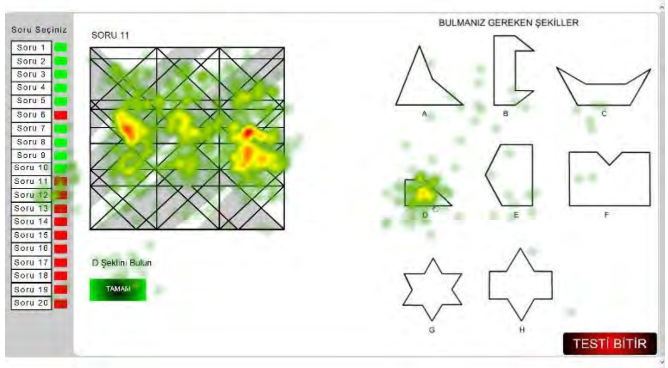
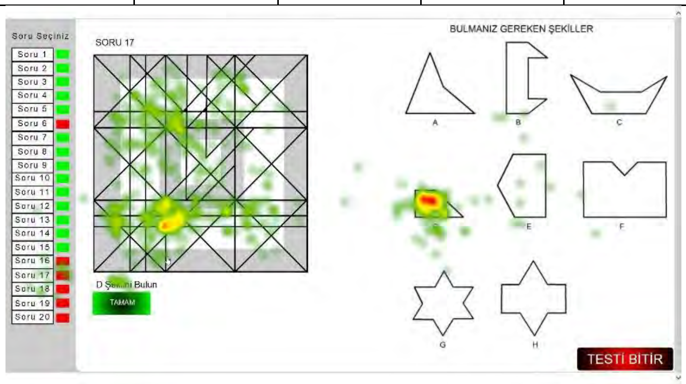
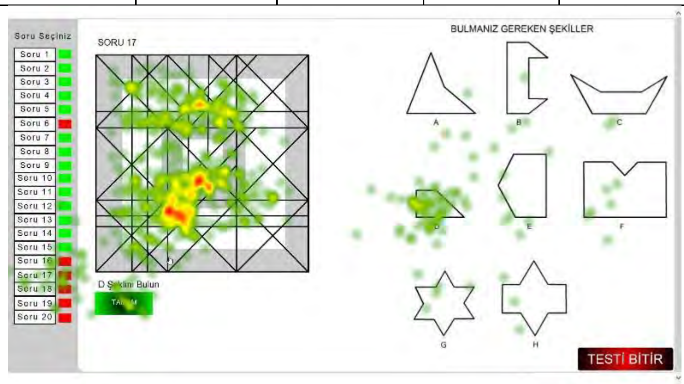
	Field Dependent (n=10)					Field Independent (n=10)				
S2										
	R= 9	W= 1	B= 0	X_{ds}= 22.3	X_{ys}= 10	R= 8	W= 2	B= 0	X_{ds}= 13.8	X_{ys}= 40
S11										
	R= 4	W= 6	B= 0	X_{ds}= 78.3	X_{ys}= 90.8	R= 10	W= 0	B= 0	X_{ds}= 43.8	X_{ys}= 0
S17										
	R= 2	W= 3	B= 5	X_{ds}= 69.5	X_{ys}= 38.3	R= 9	W= 1	B= 0	X_{ds}= 27.1	X_{ys}= 17
X_D	X_{Dd}= 5	X_{Dy}= 3.3	X_{Db}= 1.7	X_{Dds}= 43.5	X_{Dys}= 67	X_{Dd}= 9	X_{Dy}= 1	X_{Db}= 0	X_{Dds}= 29.3	X_{Dys}= 32.3

Table 18. Heat maps of preservice elementary teachers in form E

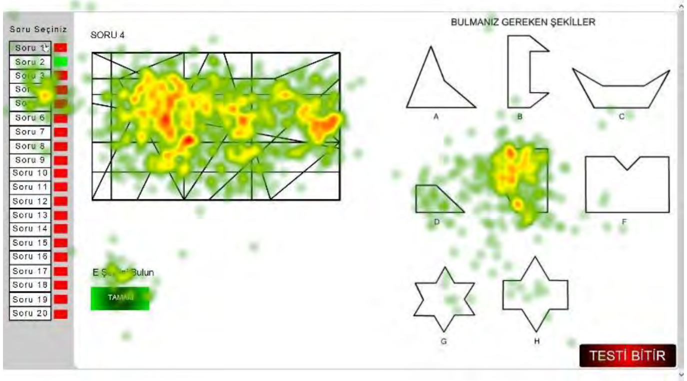
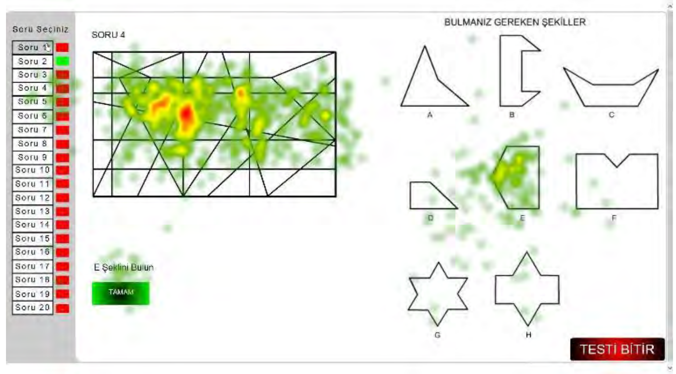
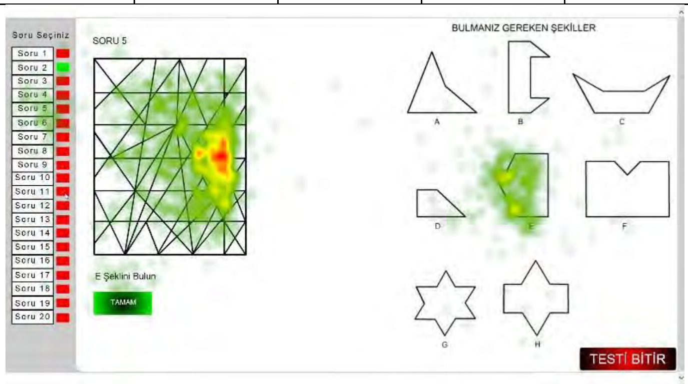
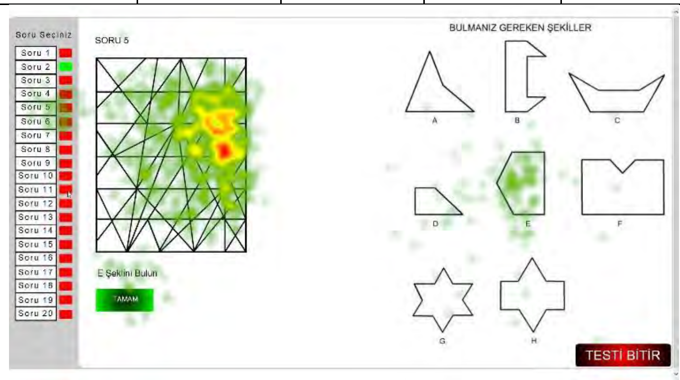
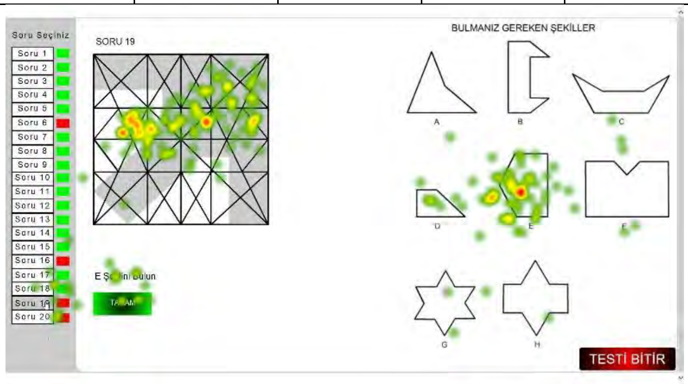
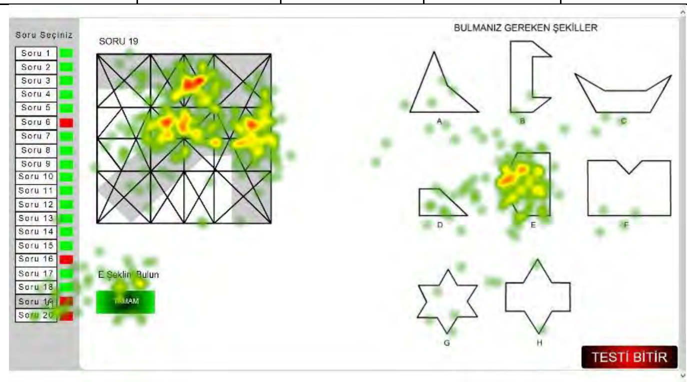
	Field Dependent (n=10)					Field Independent (n=10)				
S4										
	R= 5	W= 5	B= 0	X_{ds}= 50.2	X_{ys}= 94.2	R= 8	W= 2	B= 0	X_{ds}= 39.8	X_{ys}= 35.5
S5										
	R= 2	W= 8	B= 0	X_{ds}= 116	X_{ys}= 79.3	R= 5	W= 5	B= 0	X_{ds}= 63.4	X_{ys}= 48.8
S19										
	R= 1	W= 3	B= 6	X_{ds}= 15	X_{ys}= 26	R= 5	W= 5	B= 0	X_{ds}= 24.4	X_{ys}= 25.6
X_E	X_{Ed}= 2.7	X_{Ey}= 5.3	X_{Eb}= 2	X_{Eds}= 62.3	X_{Eys}= 73.9	X_{Ed}= 6	X_{Ey}= 4	X_{Eb}= 0	X_{Eds}= 42.1	X_{Eys}= 36.9

Table 19. Heat maps of preservice elementary teachers in form F

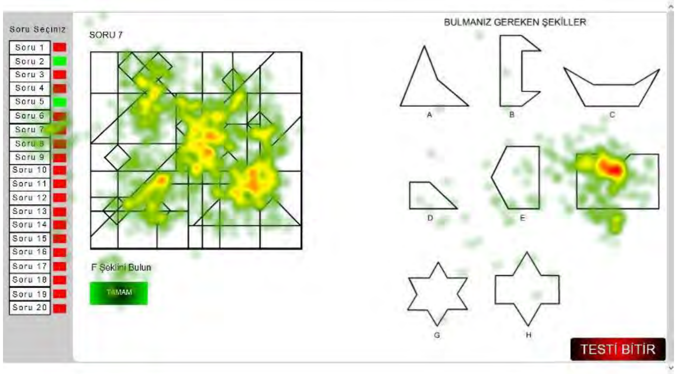
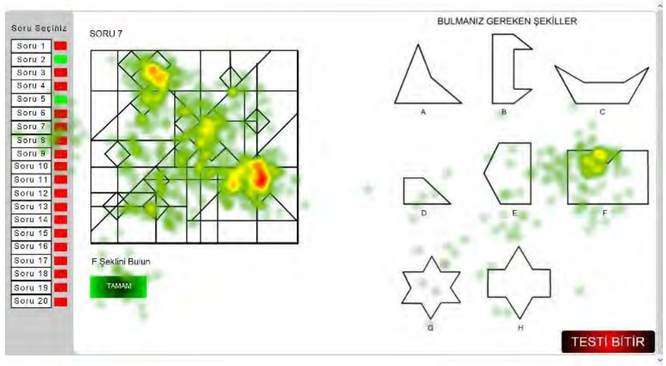
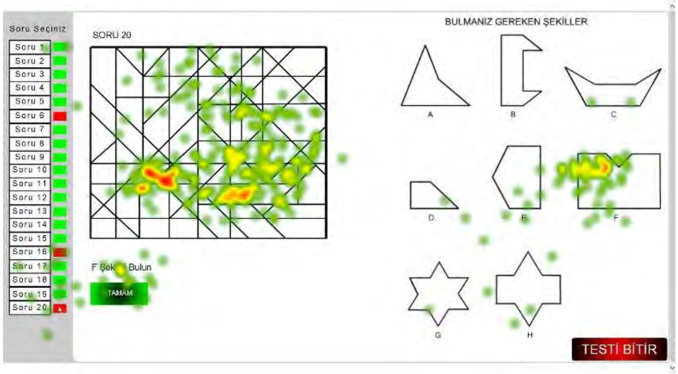
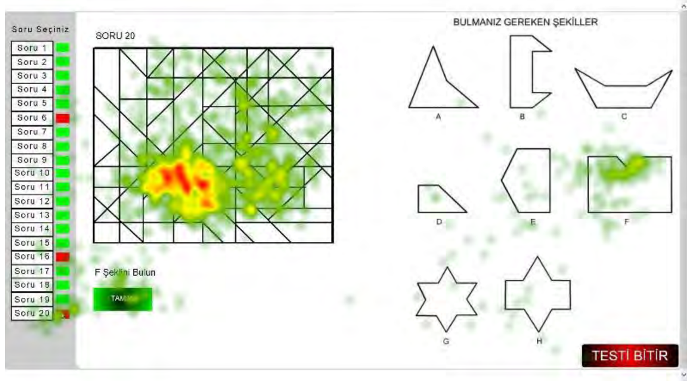
	Field Dependent (n=10)					Field Independent (n=10)				
S7										
	R= 6	W= 4	B= 0	X_{ds}= 56.2	X_{ys}= 97.5	R= 10	W= 0	B= 0	X_{ds}= 42.3	X_{ys}= 0
S20										
	R= 1	W= 3	B= 6	X_{ds}= 88	X_{ys}= 34.3	R= 5	W= 5	B= 0	X_{ds}= 49.4	X_{ys}= 102.4
X_F	X_{Fd}= 3.5	X_{Fy}= 3.5	X_{Fb}= 3	X_{Fds}= 60.7	X_{Fys}= 70.4	X_{Fd}= 7.5	X_{Fy}= 2.5	X_{Fb}= 0	X_{Fds}= 44.7	X_{Fys}= 102.4

Table 20. Heat maps of preservice elementary teachers in form G

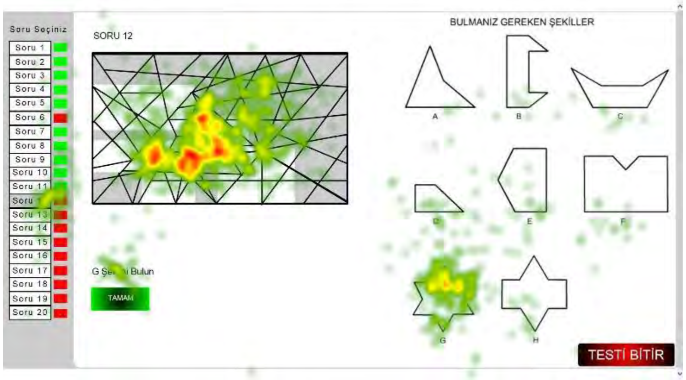
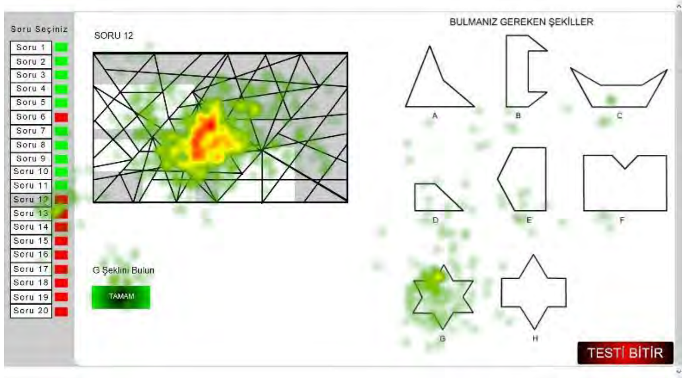
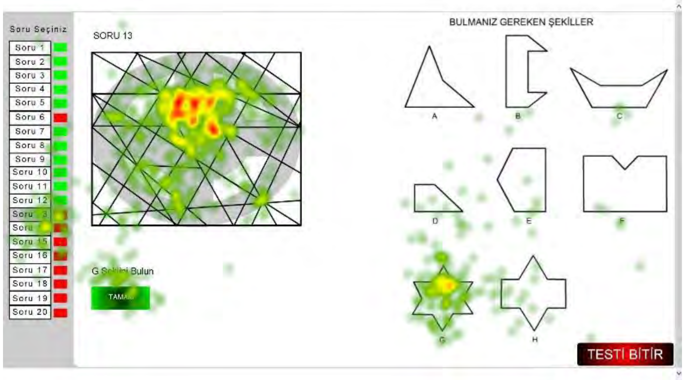
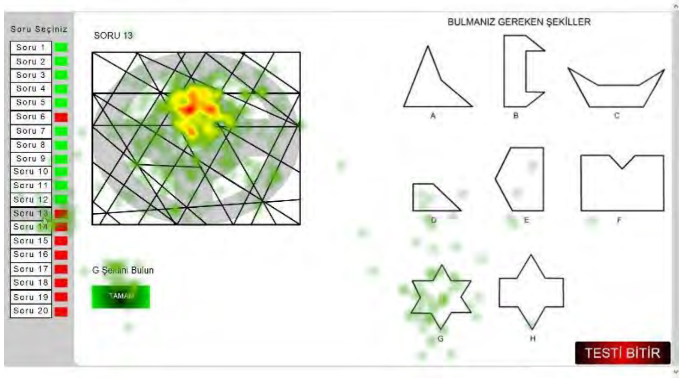
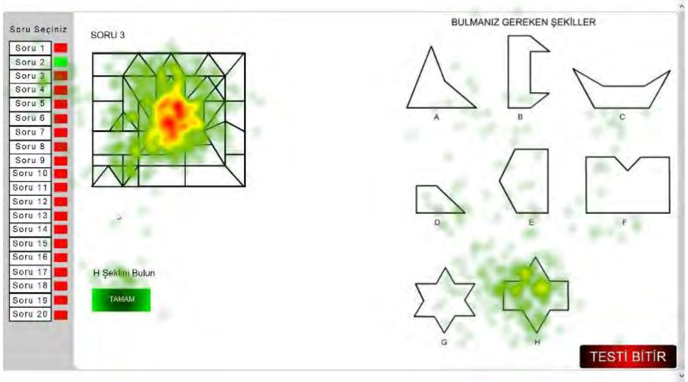
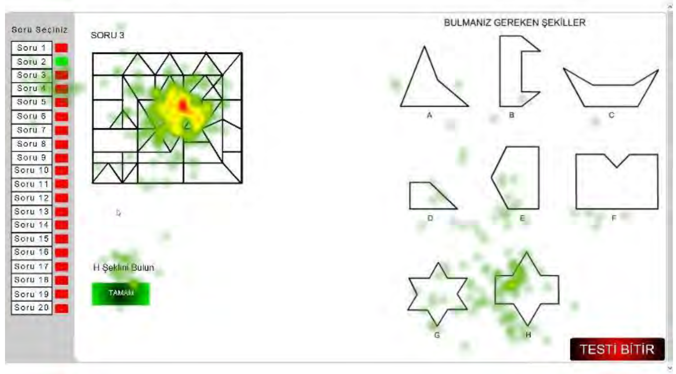
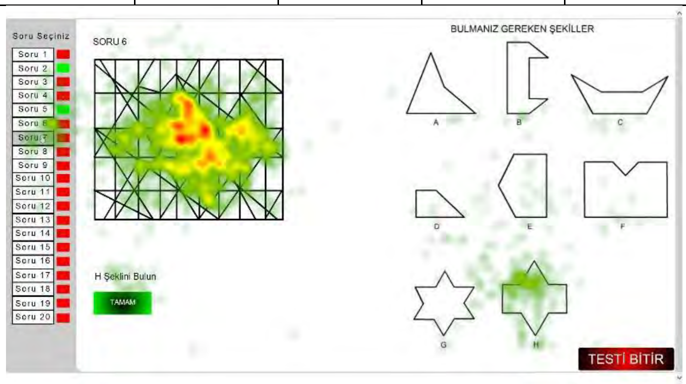
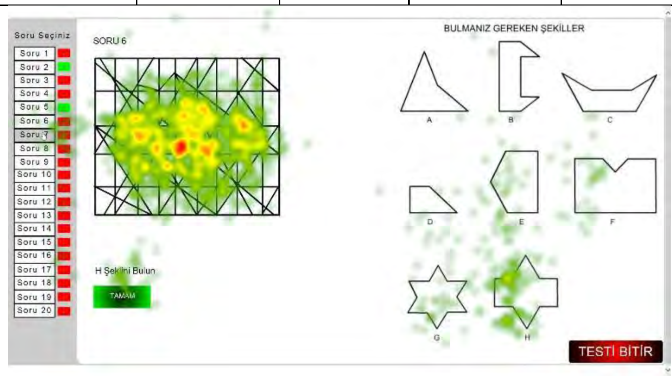
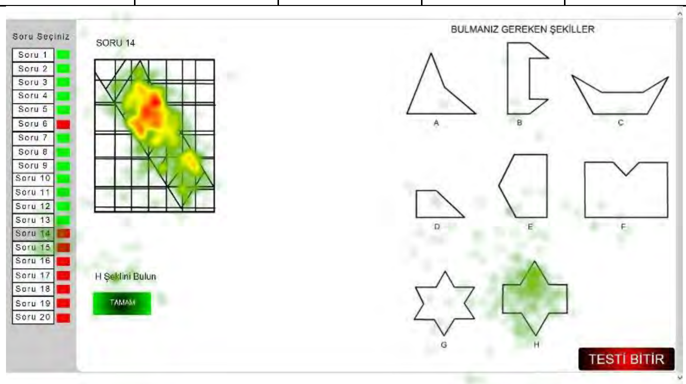
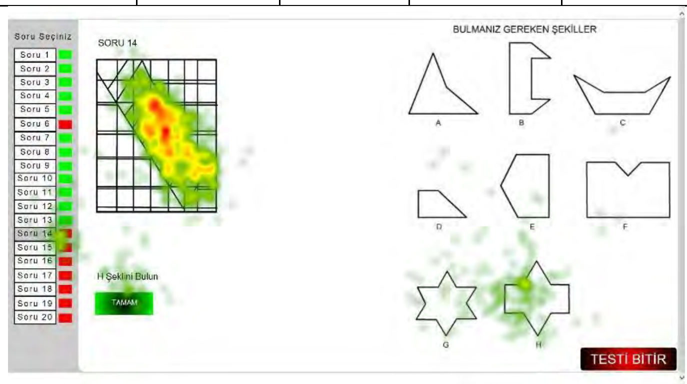
	Field Dependent (n=10)					Field Independent (n=10)				
S12										
	R= 1	W= 9	B= 0	X_{ds}= 126	X_{ys}= 60	R= 9	W= 1	B= 0	X_{ds}= 44.2	X_{ys}= 32
S13										
	R= 4	W= 4	B= 2	X_{ds}= 40.8	X_{ys}= 62.3	R= 10	W= 0	B= 0	X_{ds}= 26.2	X_{ys}= 0
X_G	X_{Gd}= 2.5	X_{Gy}= 6.5	X_{Gb}= 1	X_{Gds}= 57.8	X_{Gys}= 60.7	X_{Gd}= 9.5	X_{Gy}= 0.5	X_{Gb}= 0	X_{Gds}= 34.7	X_{Gys}= 32

Table 21. Heat maps of preservice elementary teachers in form H

<table>
<tr><th></th><th colspan="5">Field Dependent (n=10)</th><th colspan="5">Field Independent (n=10)</th></tr>
<tr><td rowspan="2">S3</td><td colspan="5">
</td><td colspan="5">
</td></tr>
<tr><td>R= 9</td><td>W= 1</td><td>B= 0</td><td>X_{ds}= 51.7</td><td>X_{ys}= 113</td><td>R= 10</td><td>W= 0</td><td>B= 0</td><td>X_{ds}= 19.9</td><td>X_{ys}= 0</td></tr>
<tr><td rowspan="2">S6</td><td colspan="5">
</td><td colspan="5">
</td></tr>
<tr><td>R= 3</td><td>W= 6</td><td>B= 1</td><td>X_{ds}= 78</td><td>X_{ys}= 135.7</td><td>R= 8</td><td>W= 2</td><td>B= 0</td><td>X_{ds}= 84.6</td><td>X_{ys}= 74</td></tr>
<tr><td rowspan="2">S14</td><td colspan="5">
</td><td colspan="5">
</td></tr>
<tr><td>R= 1</td><td>W= 7</td><td>B= 2</td><td>X_{ds}= 202</td><td>X_{ys}= 65.1</td><td>R= 4</td><td>W= 6</td><td>B= 0</td><td>X_{ds}= 53.8</td><td>X_{ys}= 57.3</td></tr>
<tr><td>X_H</td><td>X_{Hd}= 4.3</td><td>X_{Hy}= 4.7</td><td>X_{Hb}= 1</td><td>X_{Hds}= 69.3</td><td>X_{Hys}= 98.8</td><td>X_{Hd}= 7.3</td><td>X_{Hy}= 2.7</td><td>X_{Hb}= 0</td><td>X_{Hds}= 49.6</td><td>X_{Hys}= 61.5</td></tr>
</table>

APPENDIX 2

Heat Map, Gaze Plot and Cluster Data of Field Dependent and Field Independent Preservice Elementary Teachers

Table 22. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 1

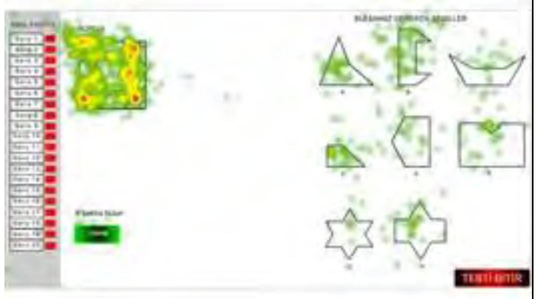
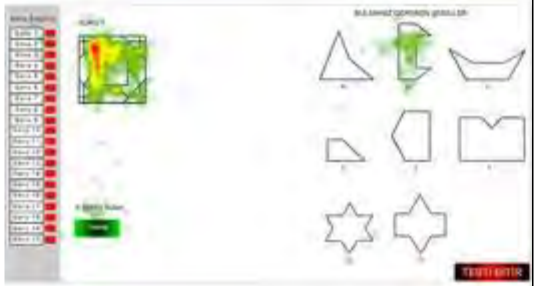
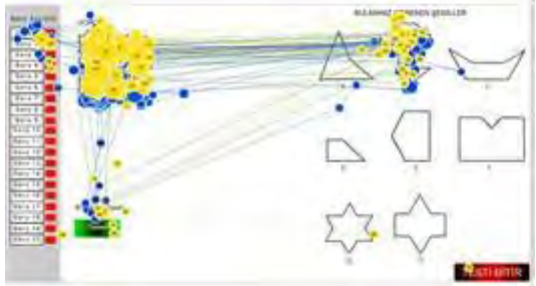
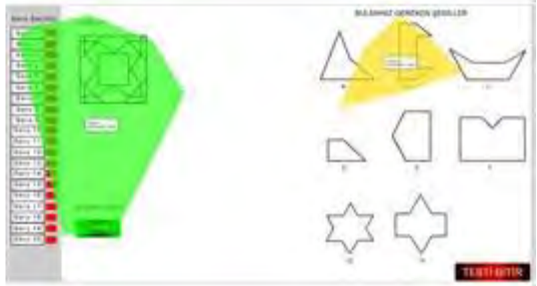
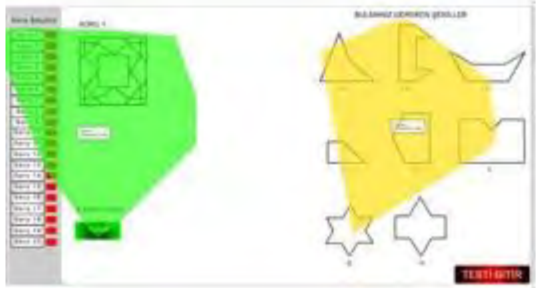
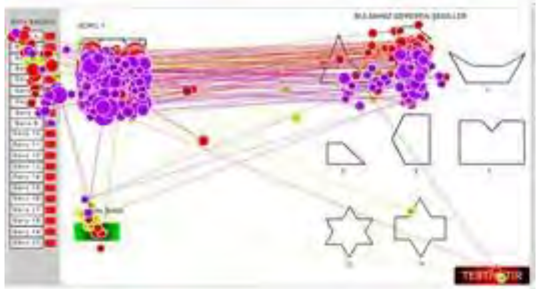
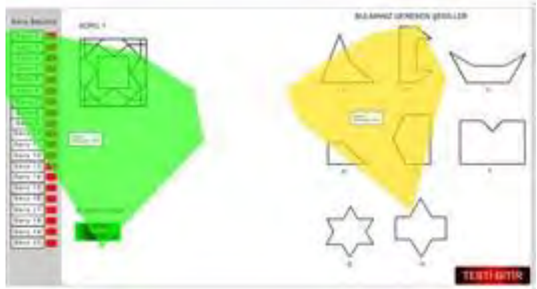
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	1			
		Male	2			
	Incorrect answer	Female	4			
		Male	3			

Table 23. Images of Field Independent Preservice Elementary Teachers' Answers to Question 1

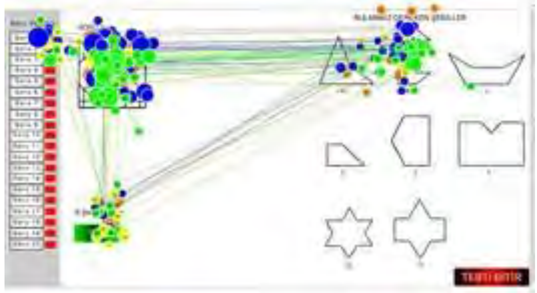
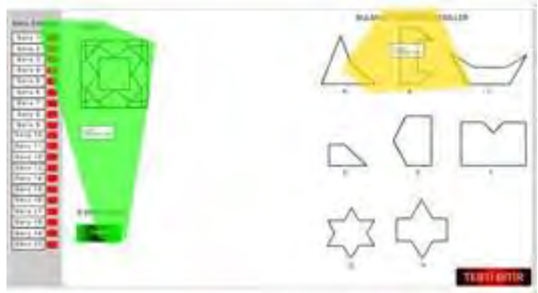
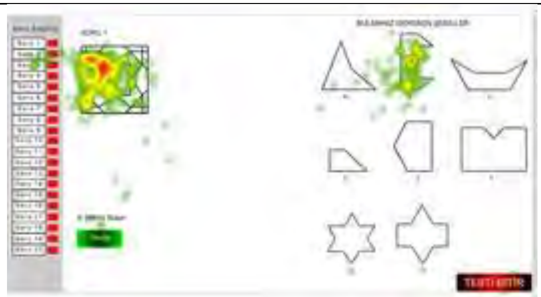
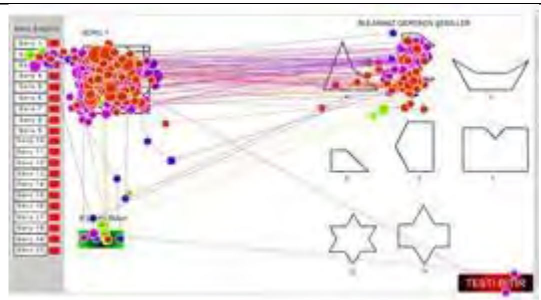
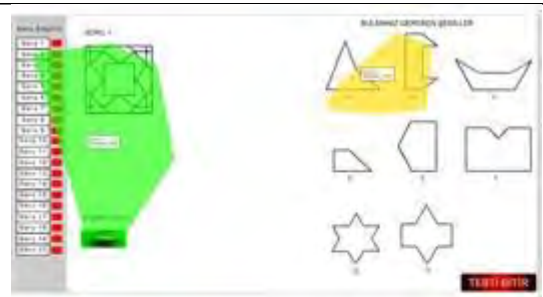
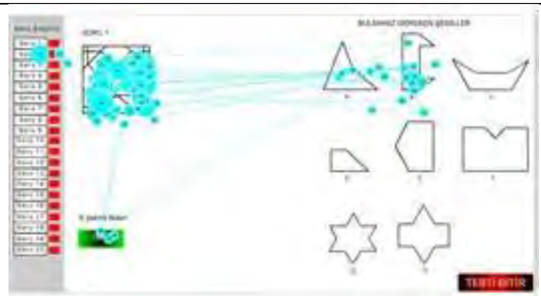
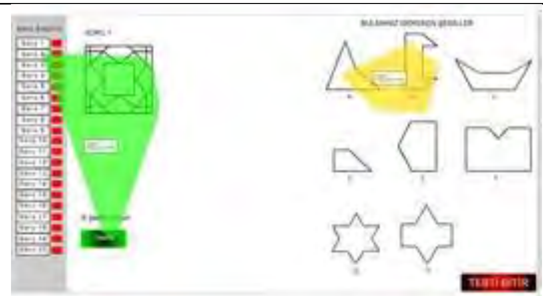
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	5			
		Male	4			
	Incorrect answer	Female	-	-----	-----	-----
		Male	1			

Table 24. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 2

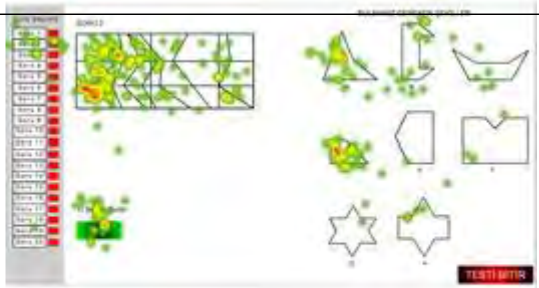
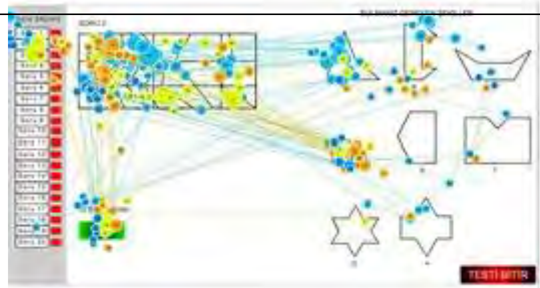
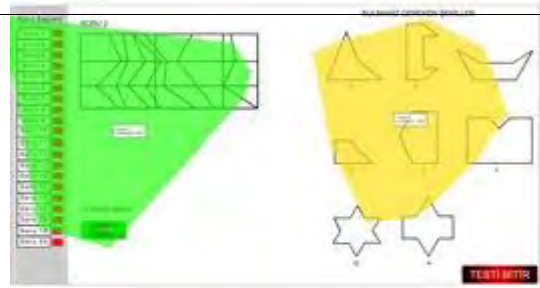
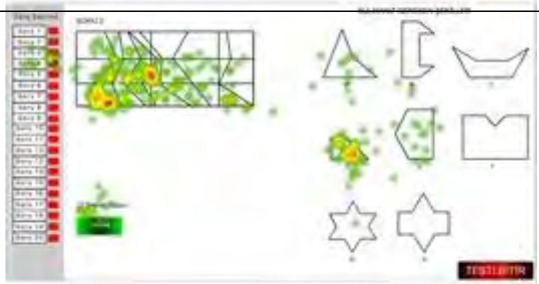
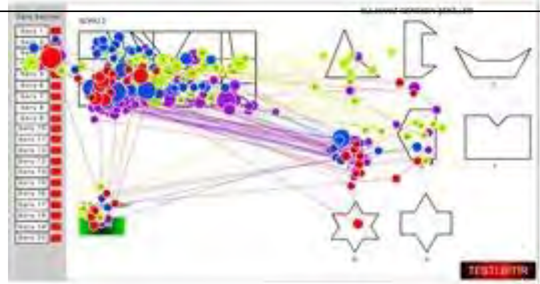
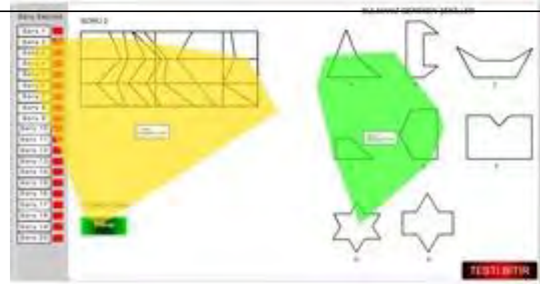
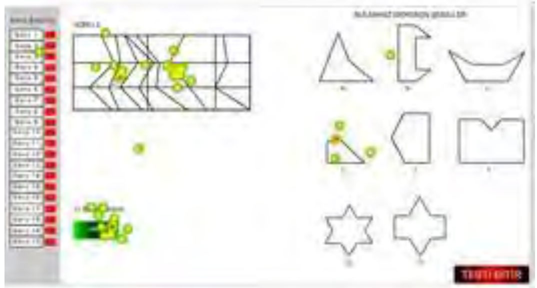
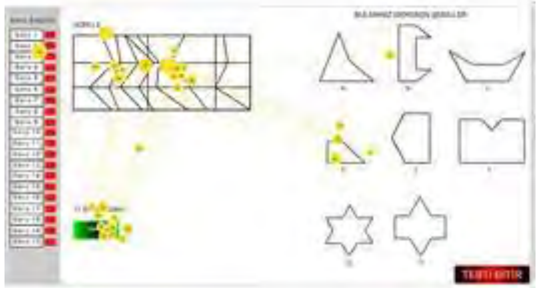
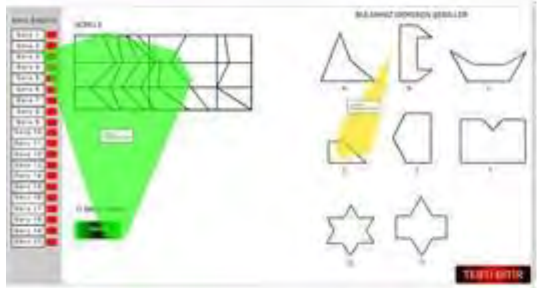
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	**Correct answer**	Female	5			
		Male	4			
	Incorrect answer	Female	-	-----	-----	-----
		Male	1			

Table 25. Images of Field Independent Preservice Elementary Teachers' Answers to Question 2

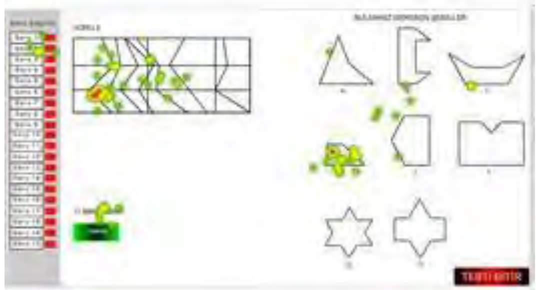
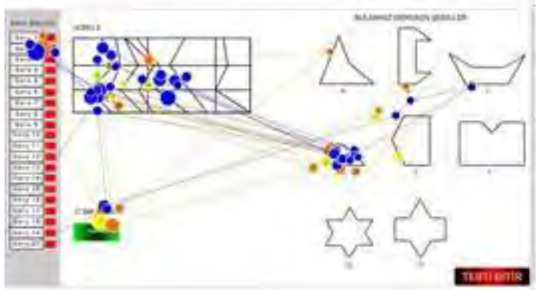
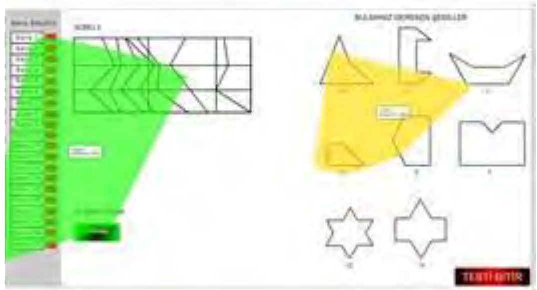
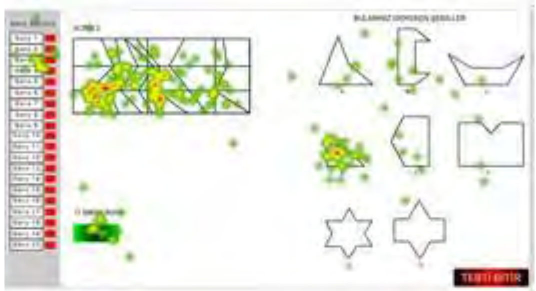
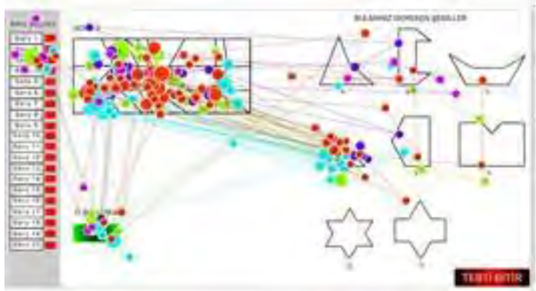
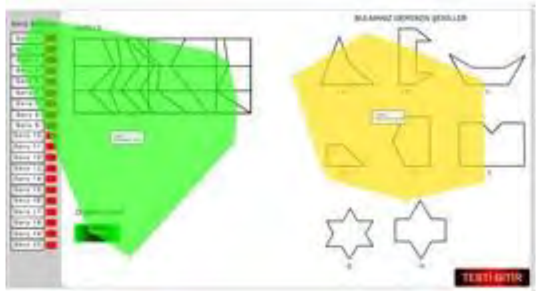
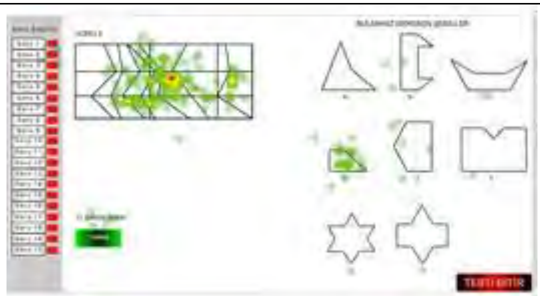
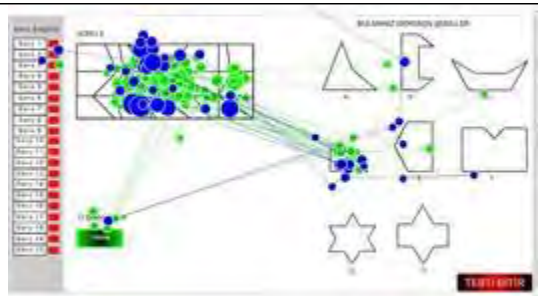
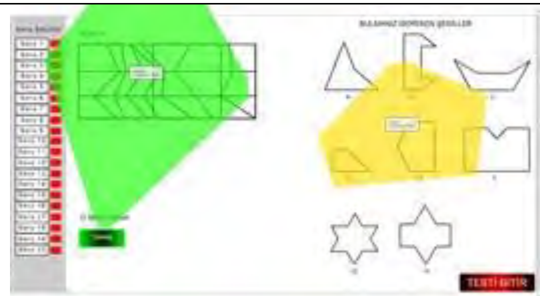
Situation			**N**	**Heatmap**	**Gaze plot**	**Cluster**
Field Independent	**Correct answer**	Female	3			
		Male	5			
	Incorrect answer	Female	2			
		Male	-	-----	-----	-----

Table 26. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 3

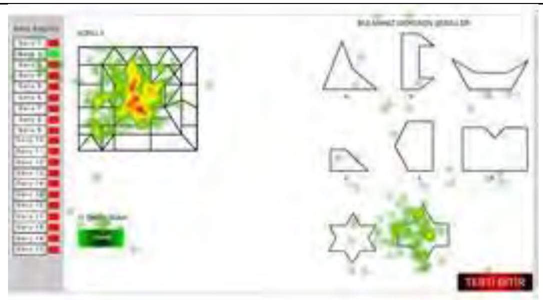
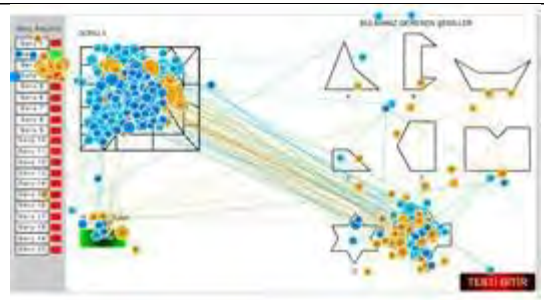
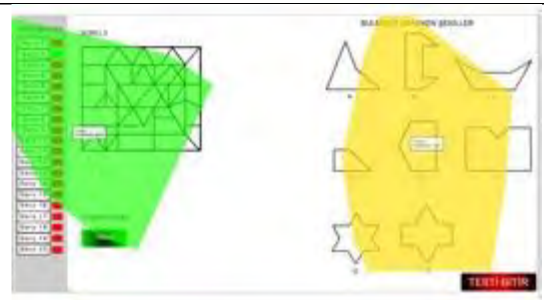
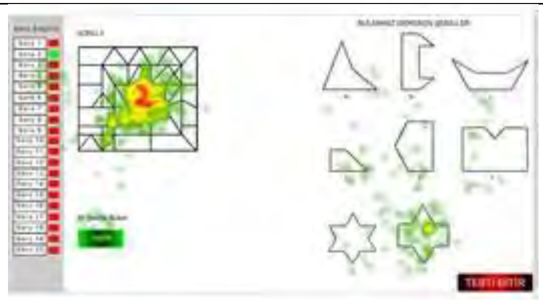
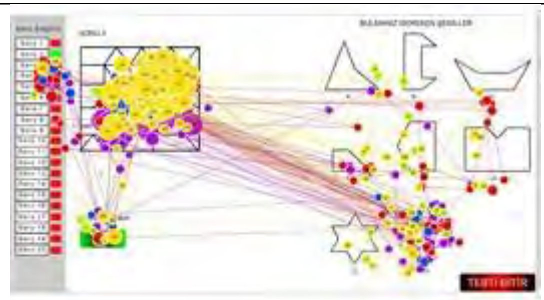
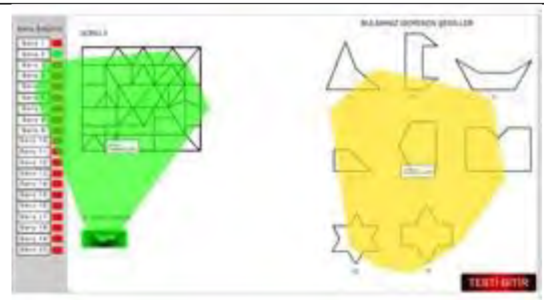
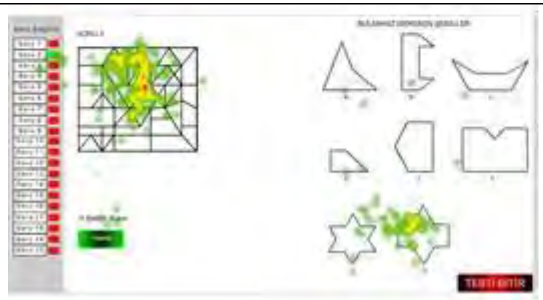
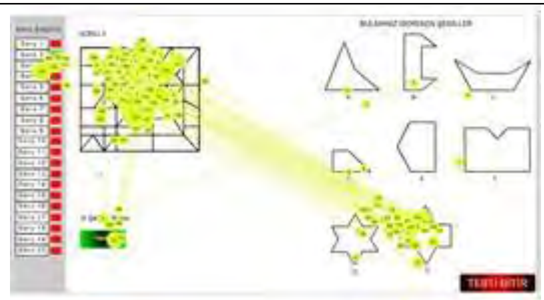
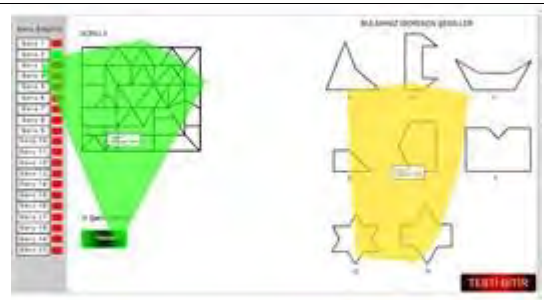
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	4			
		Male	5			
	Incorrect answer	Female	1			
		Male	-	-----	-----	-----

Table 27. Images of Field Independent Preservice Elementary Teachers' Answers to Question 3

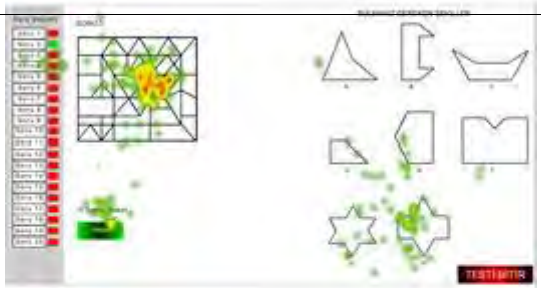
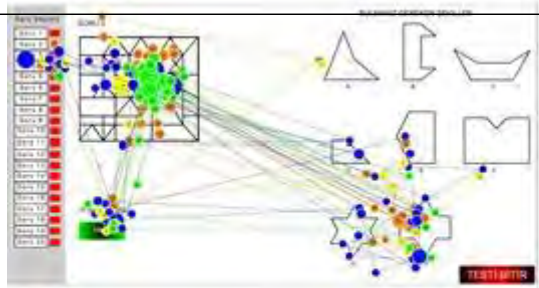
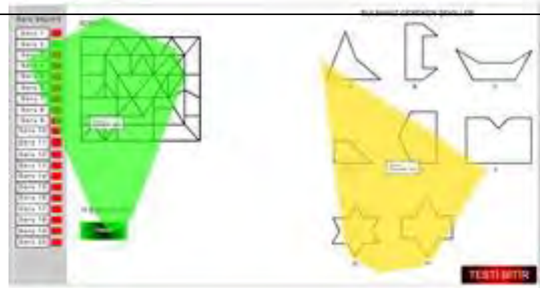
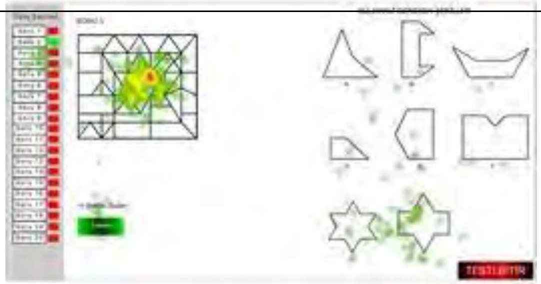
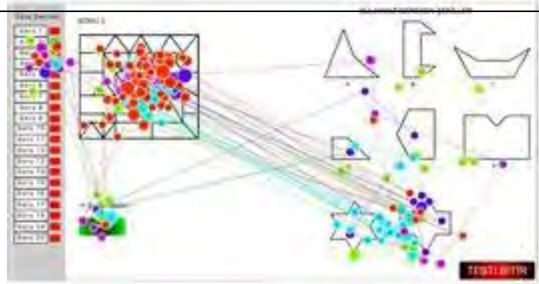
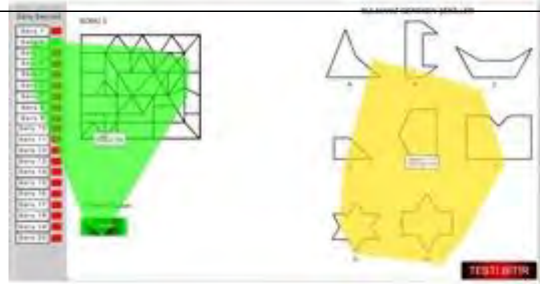
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	5			
		Male	5			
	Incorrect answer	Female	-	-----	-----	-----
		Male	-	-----	-----	-----

Table 28. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 4

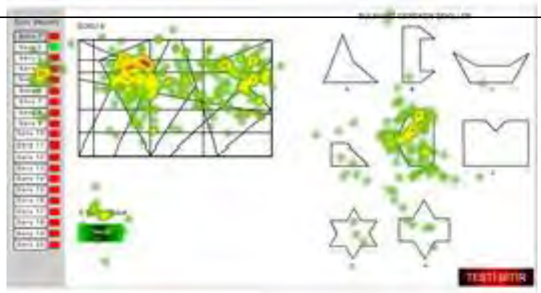
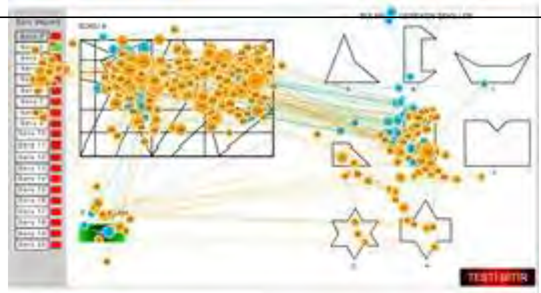
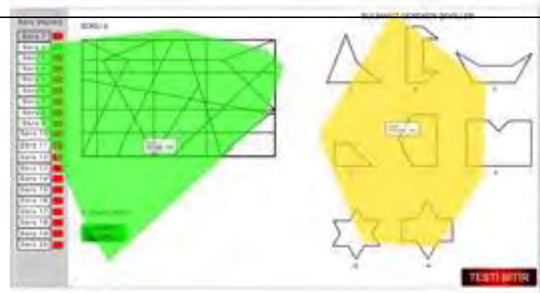
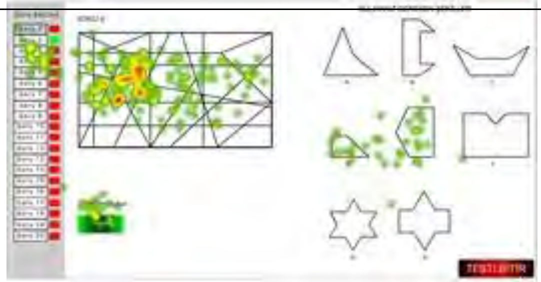
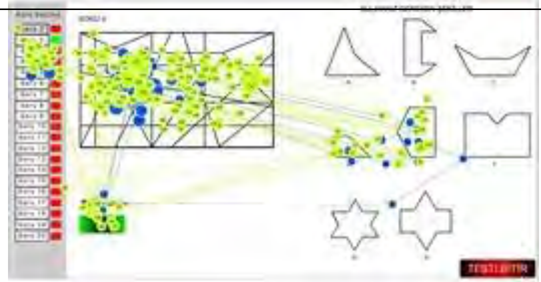
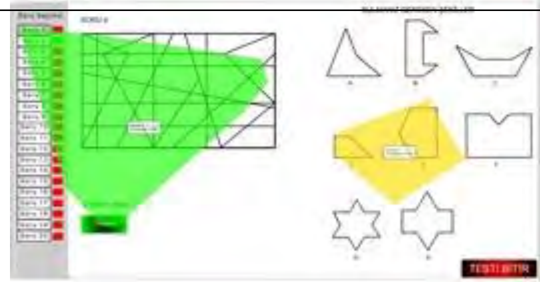
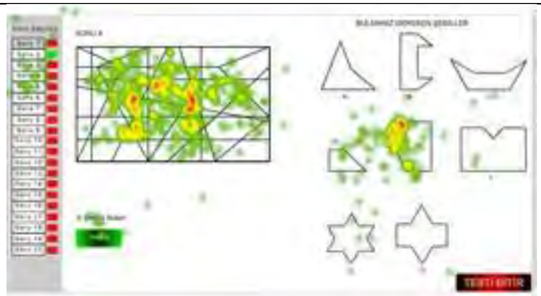
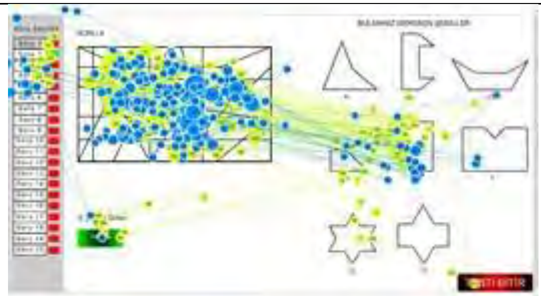
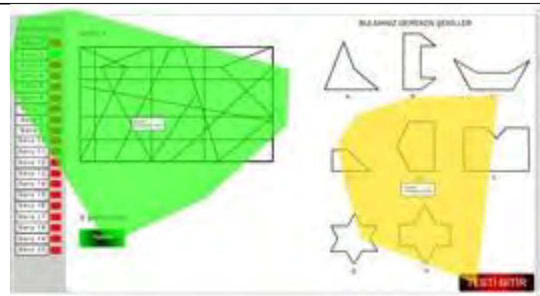
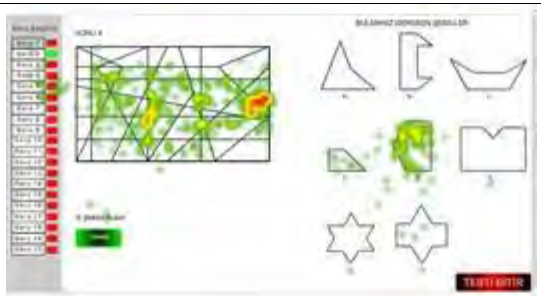
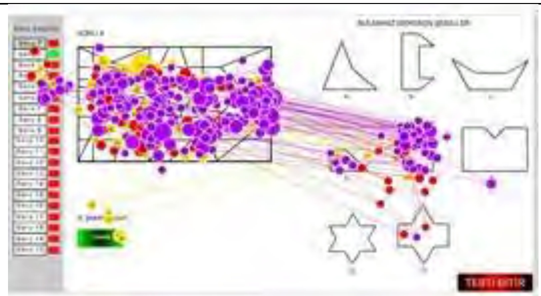
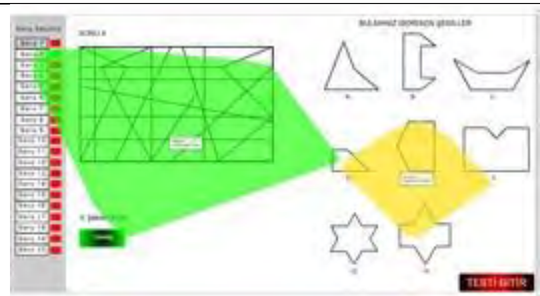
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	3			
		Male	2			
	Incorrect answer	Female	2			
		Male	3			

Table 29. Images of Field Independent Preservice Elementary Teachers' Answers to Question 4

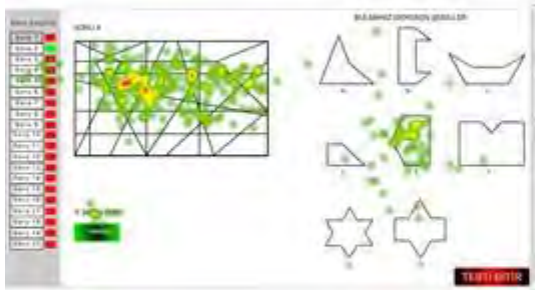
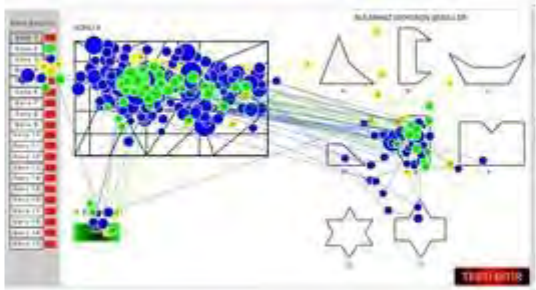
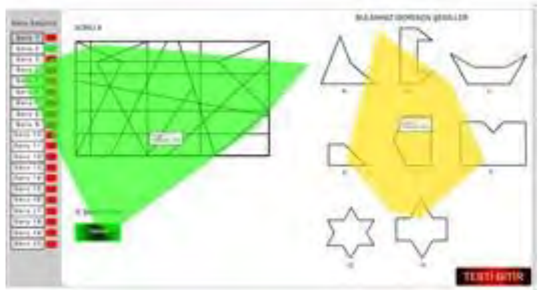
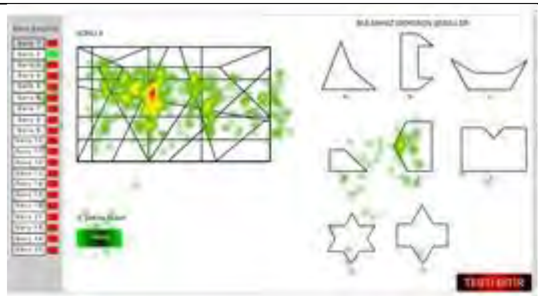
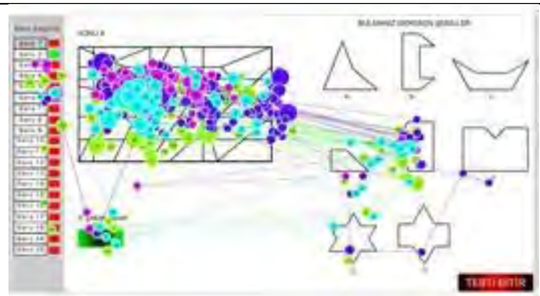
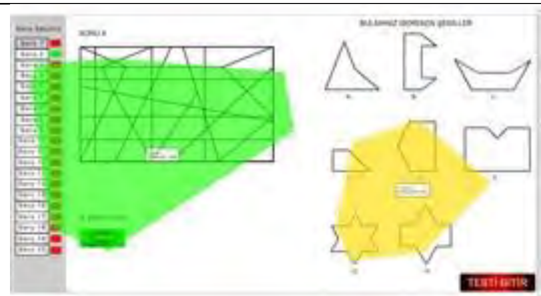
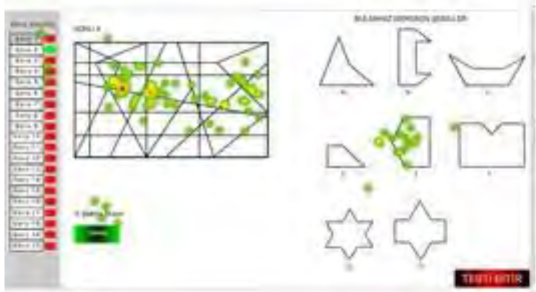
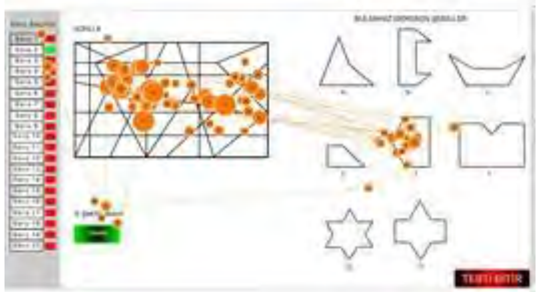
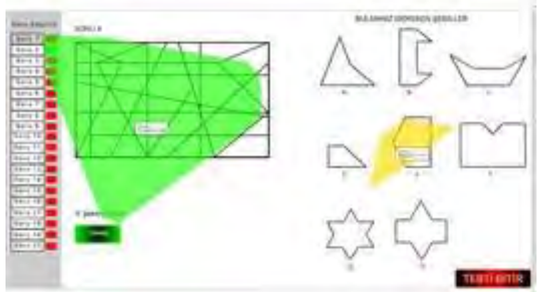
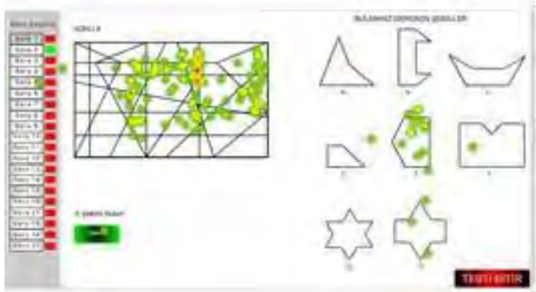
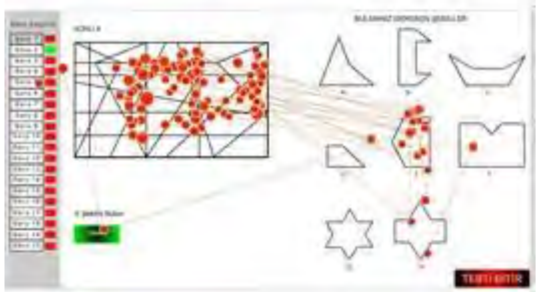
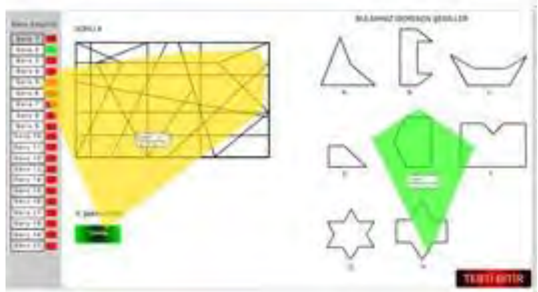
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	4			
		Male	4			
	Incorrect answer	Female	1			
		Male	1			

Table 30. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 5

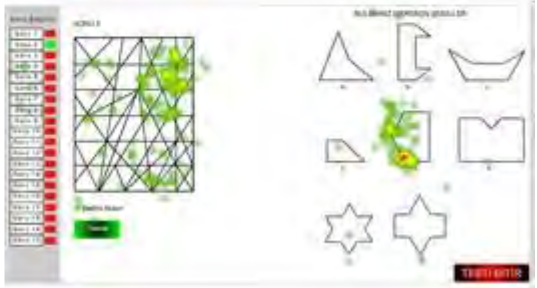
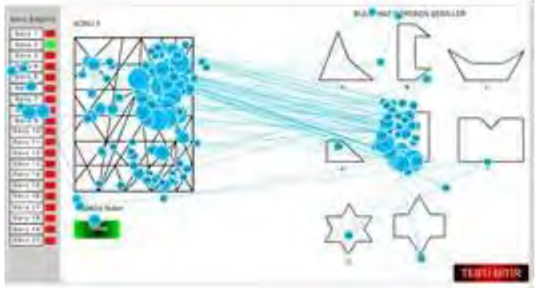
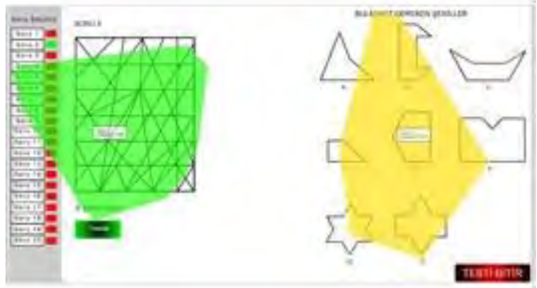
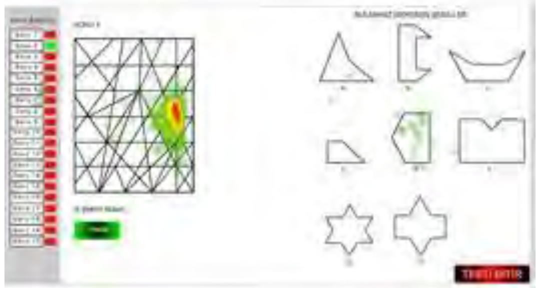
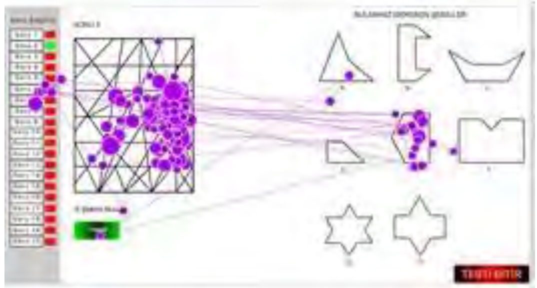
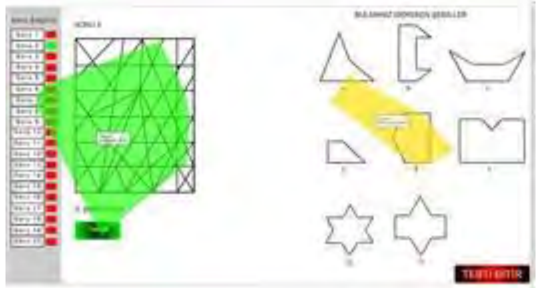
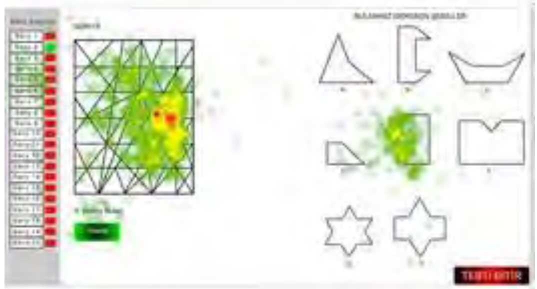
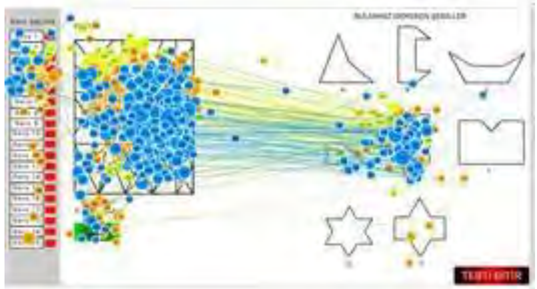
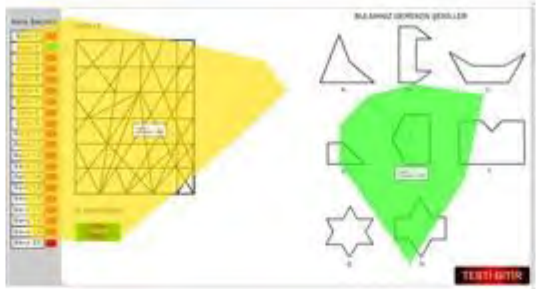
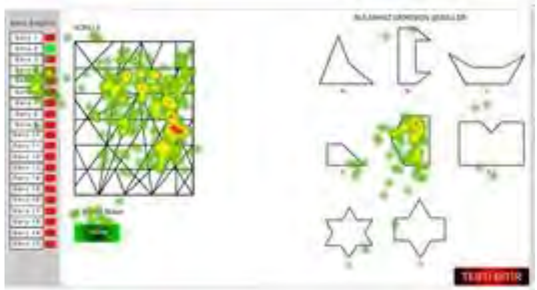
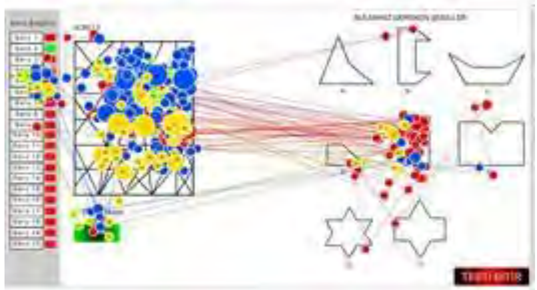
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	1			
		Male	1			
	Incorrect answer	Female	4			
		Male	4			

Table 31. Images of Field Independent Preservice Elementary Teachers' Answers to Question 5

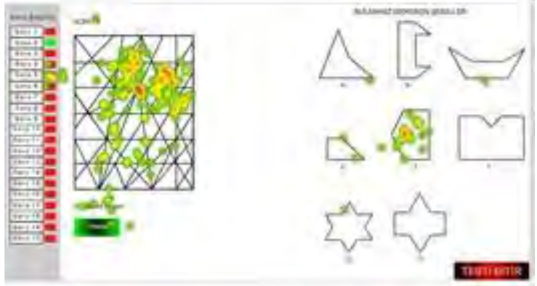
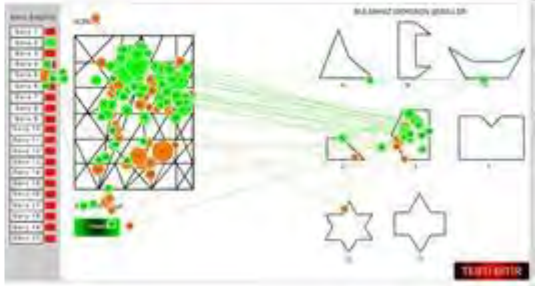
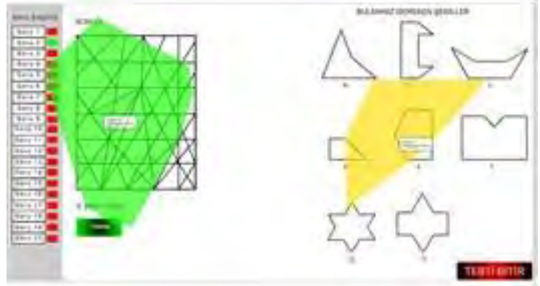
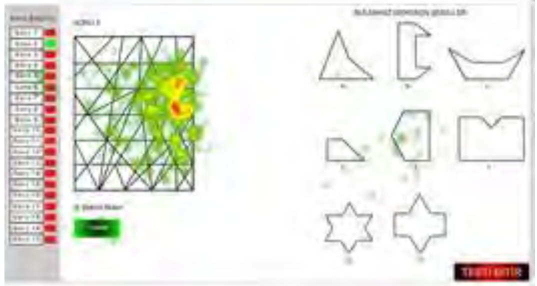
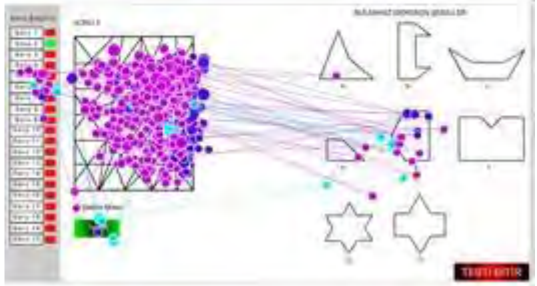
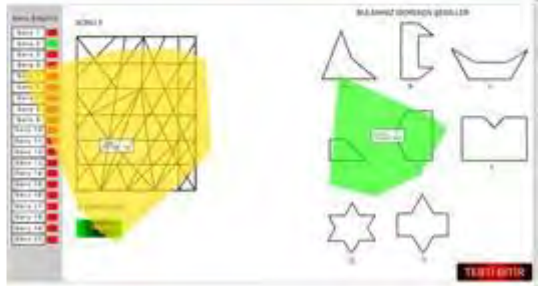
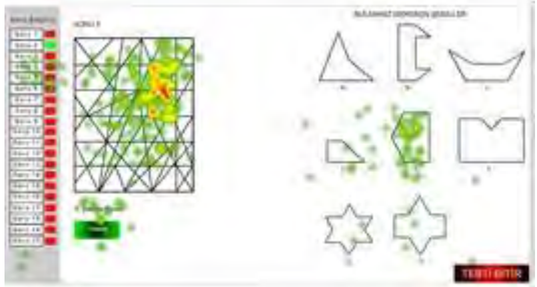
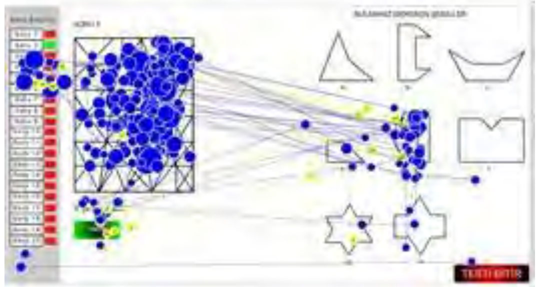
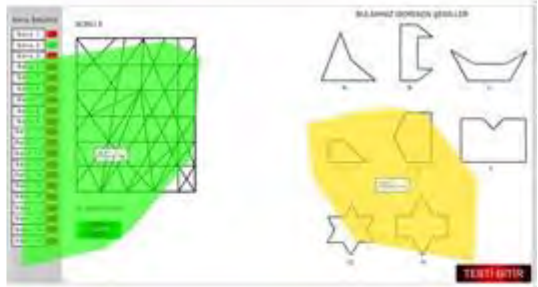
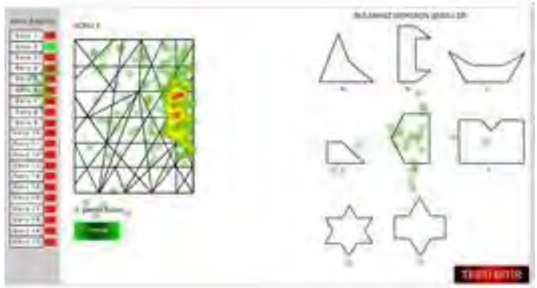
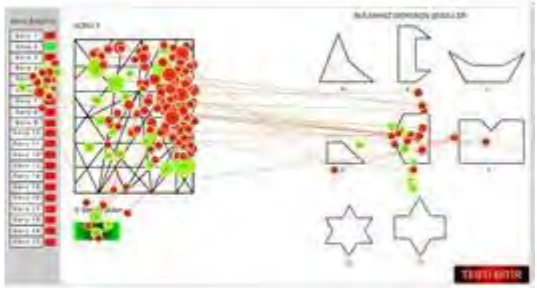
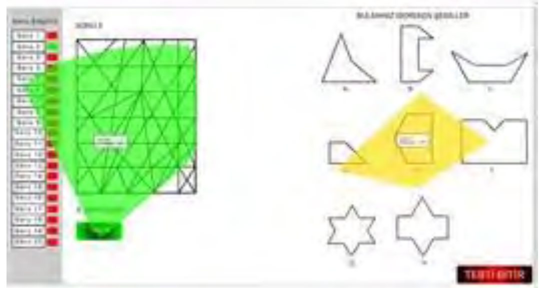
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	2			
		Male	3			
	Incorrect answer	Female	3			
		Male	2			

Table 32. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 6

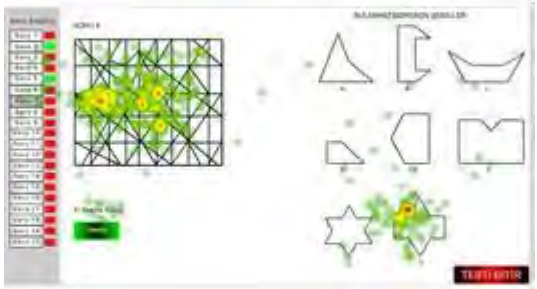
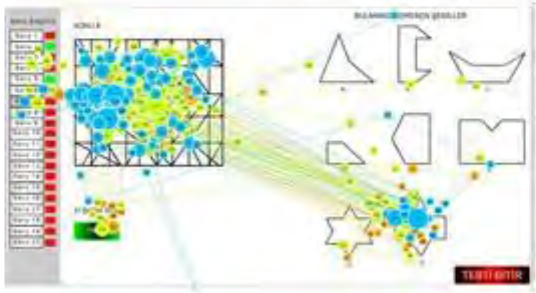
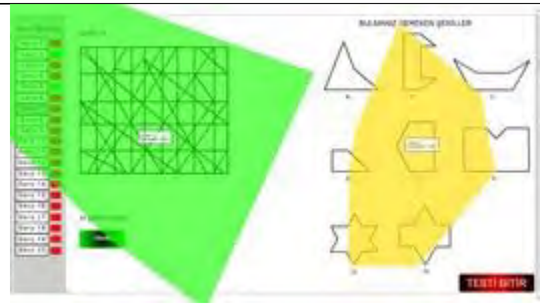
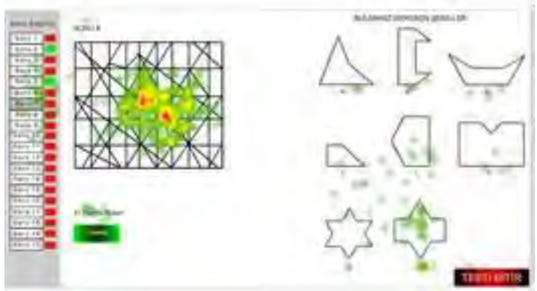
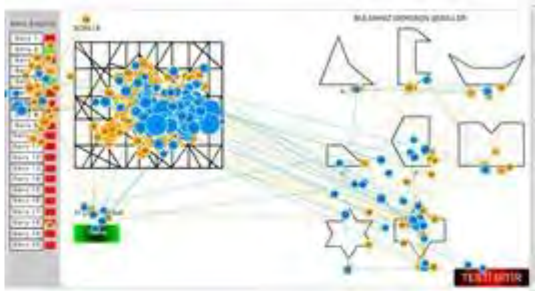
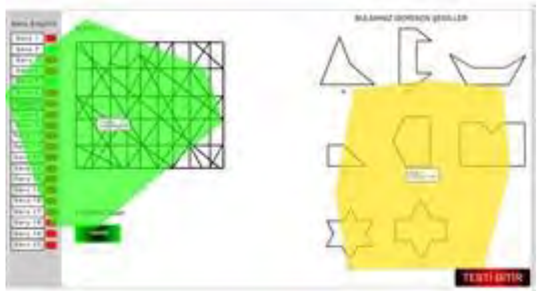
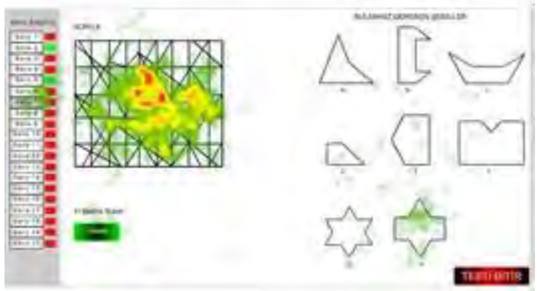
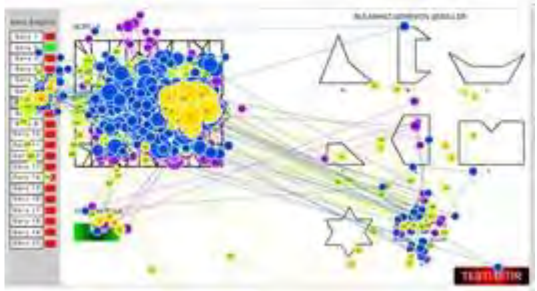
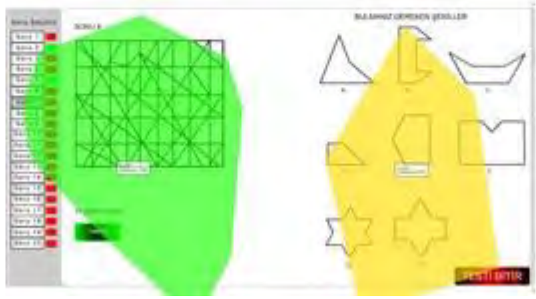
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	3			
		Male	-	-----	-----	-----
	Incorrect answer	Female	2			
		Male	4			

Table 33. Images of Field Independent Preservice Elementary Teachers' Answers to Question 6

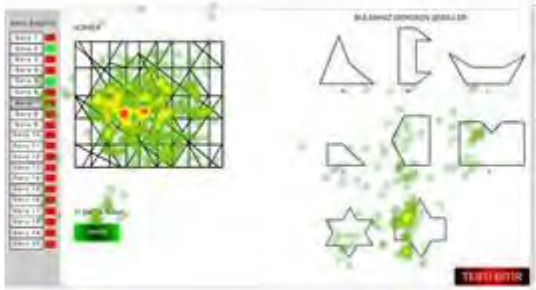
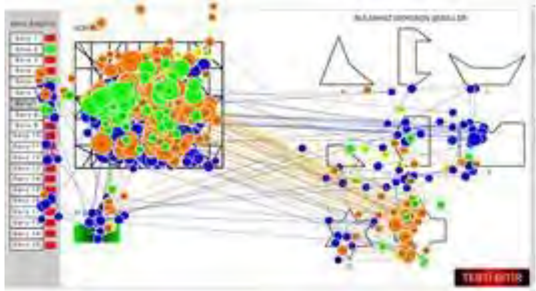
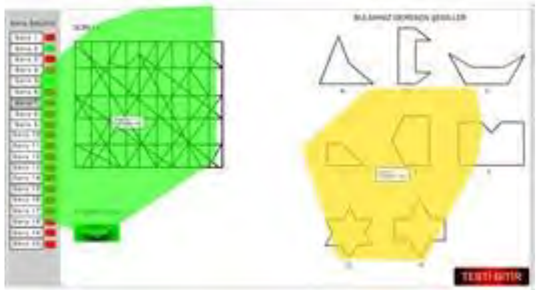
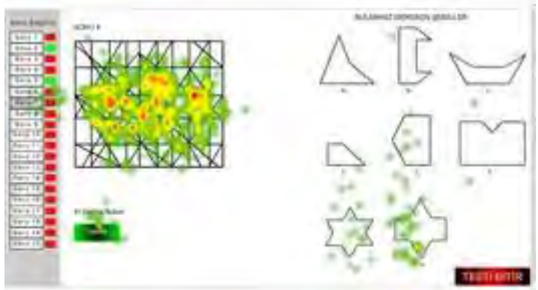
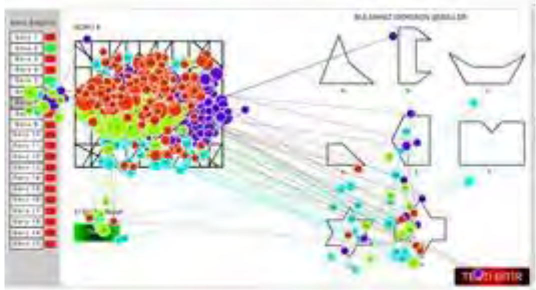
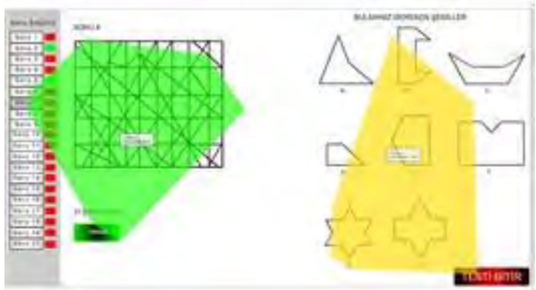
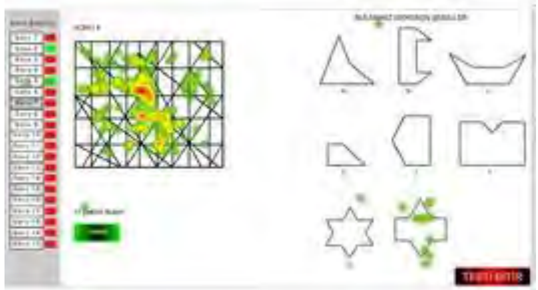
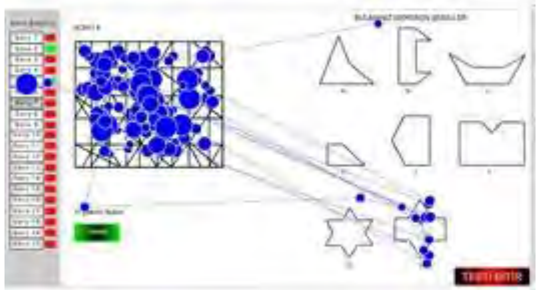
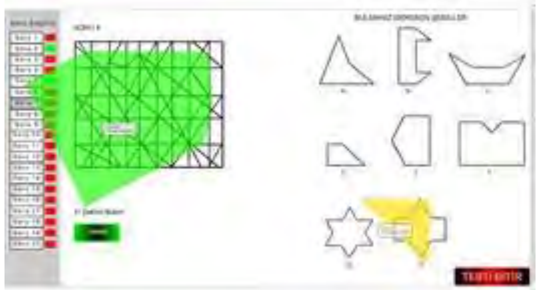
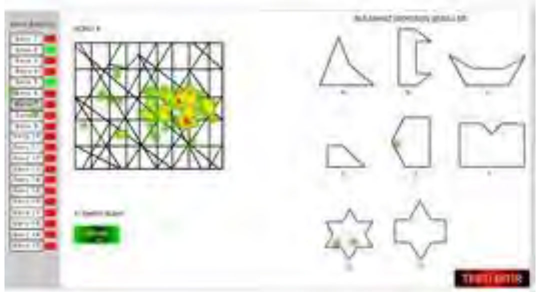
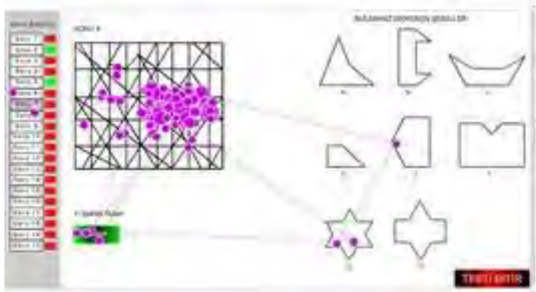
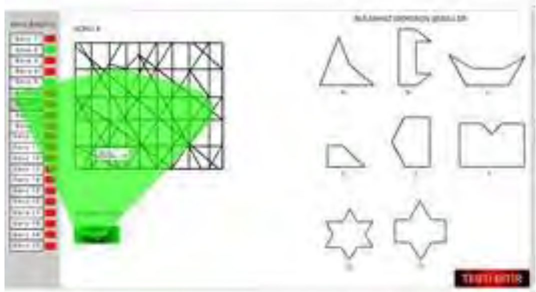
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	4			
		Male	4			
	Incorrect answer	Female	1			
		Male	1			

Table 34. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 7

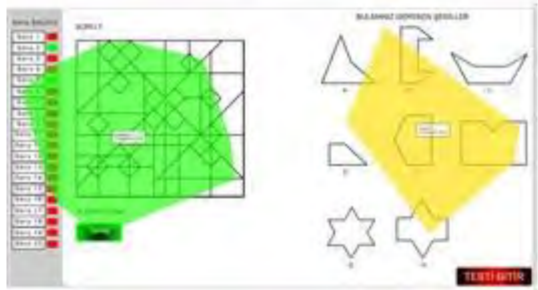
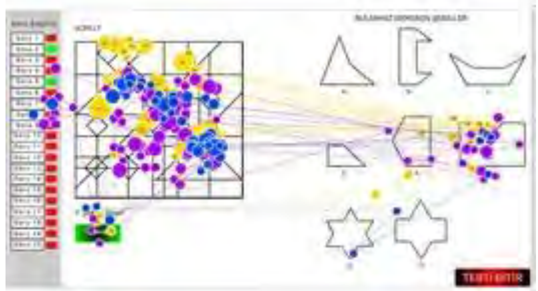
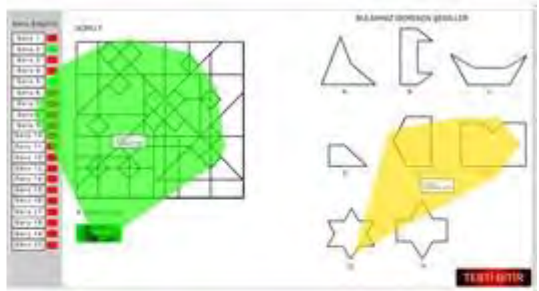
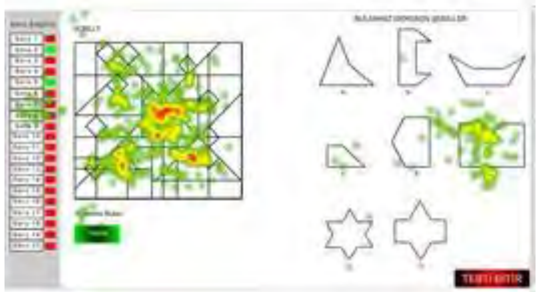
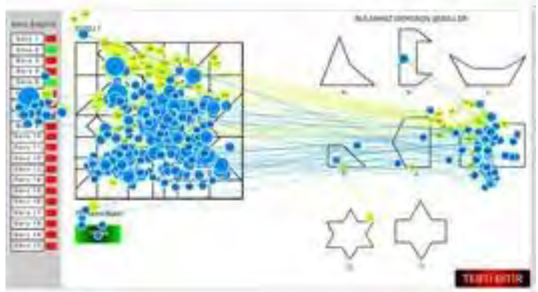
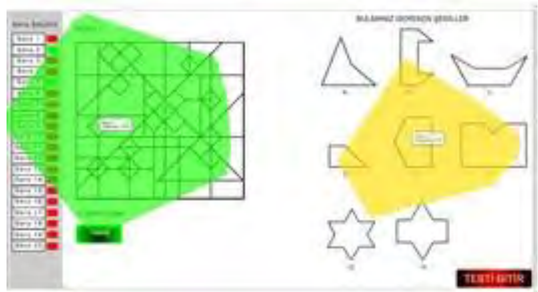
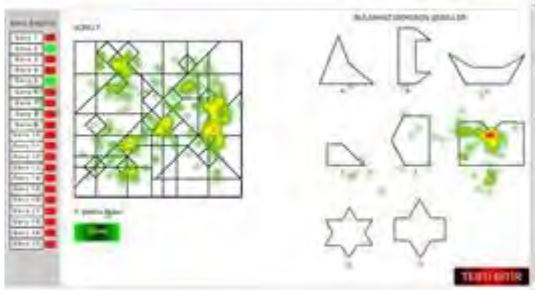
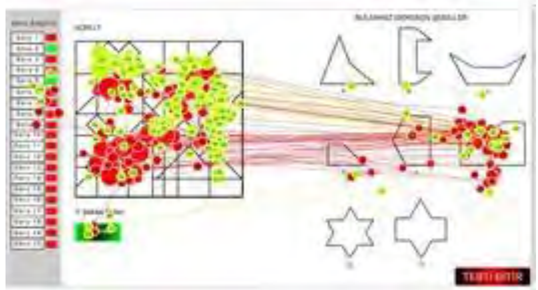
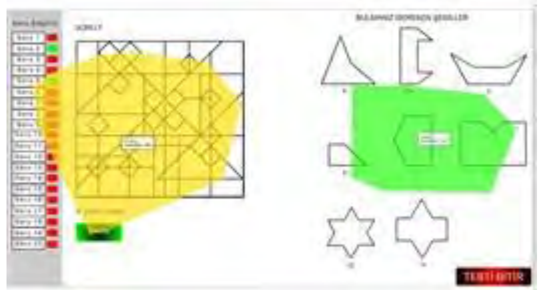
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	3			
		Male	3			
	Incorrect answer	Female	2			
		Male	2			

Table 35. Images of Field Independent Preservice Elementary Teachers' Answers to Question 7

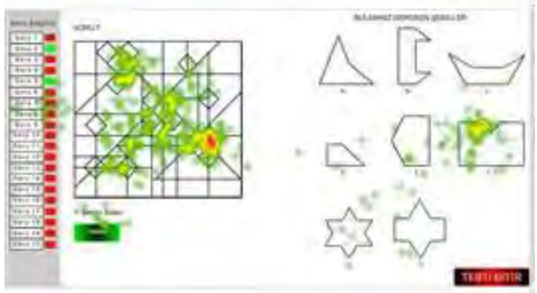
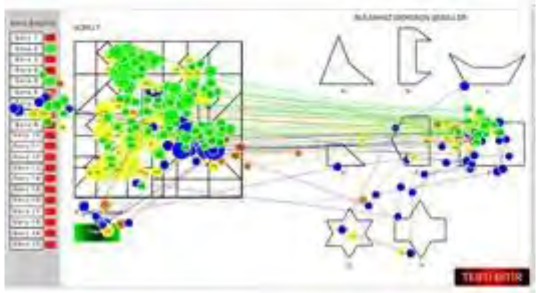
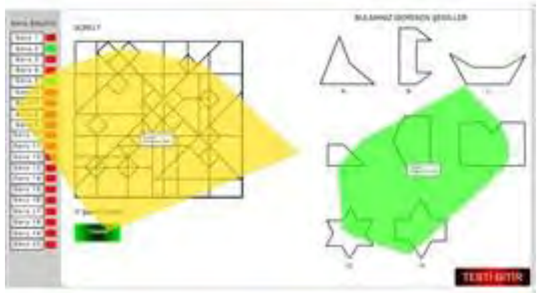
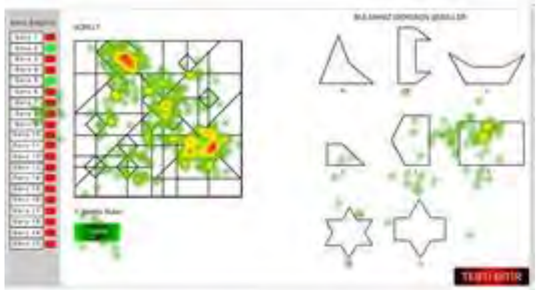
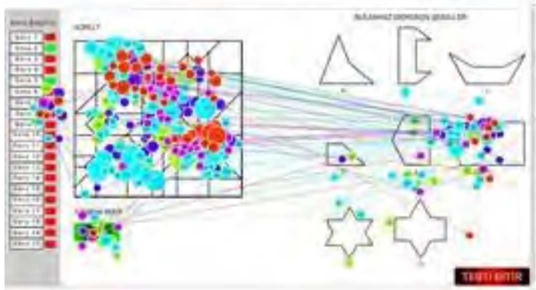
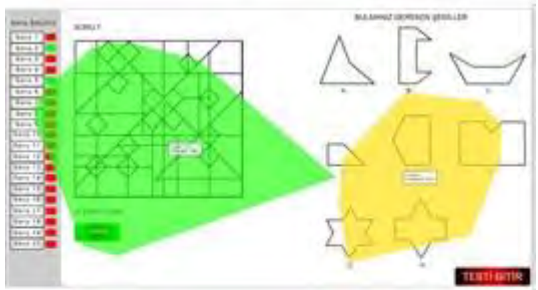
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	5			
		Male	5			
	Incorrect answer	Female	-	-----	-----	-----
		Male	-	-----	-----	-----

Table 36. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 8

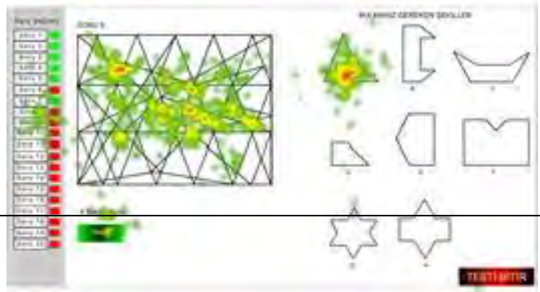
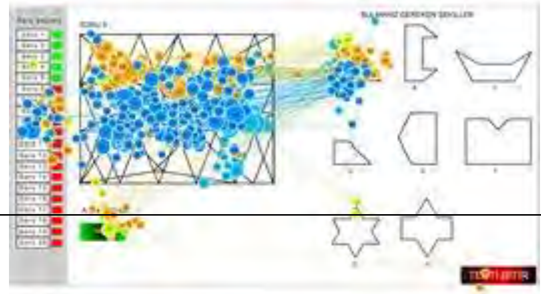
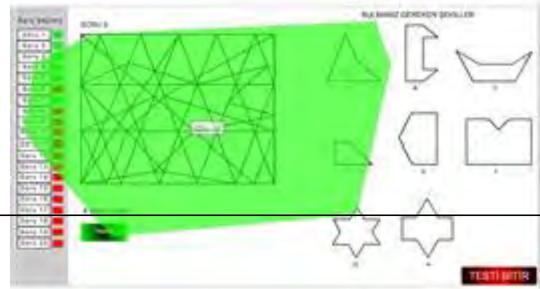
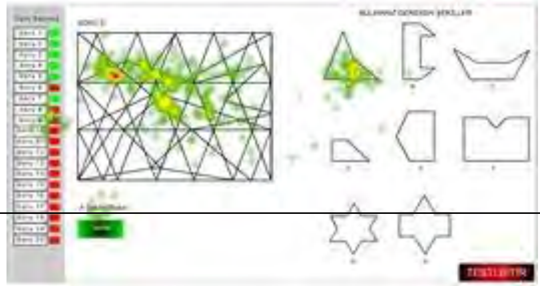
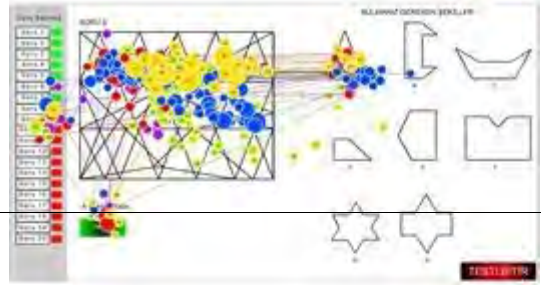
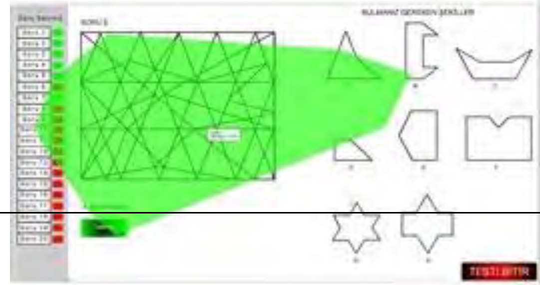
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	-	-----	-----	-----
		Male	-	-----	-----	-----
	Incorrect answer	Female	5			
		Male	5			

Table 37. Images of Field Independent Preservice Elementary Teachers' Answers to Question 8

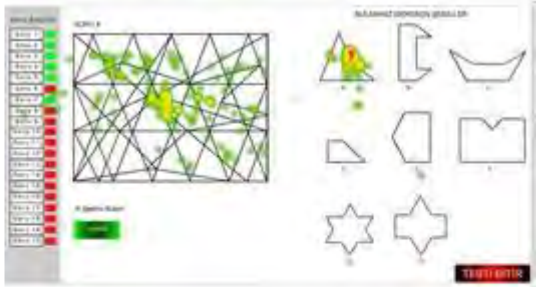
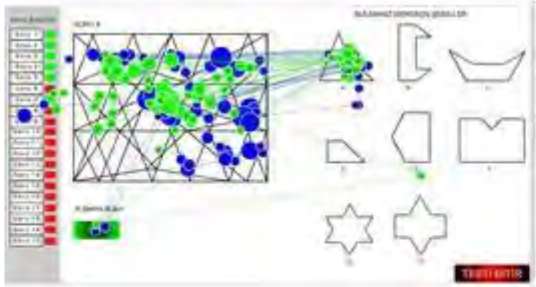
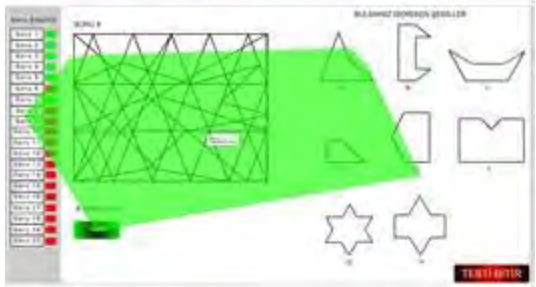
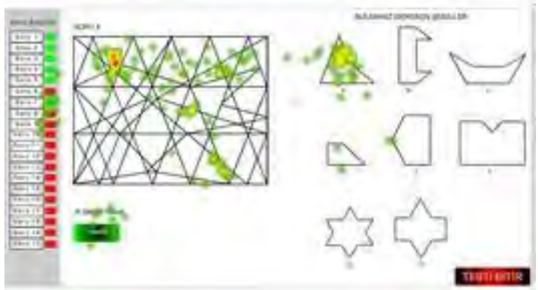
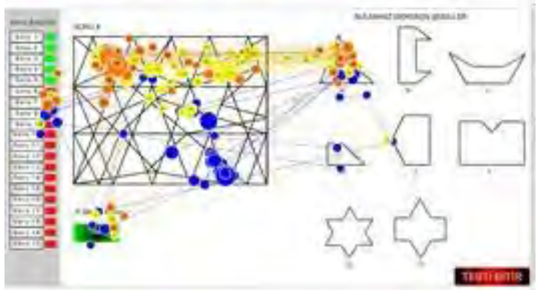
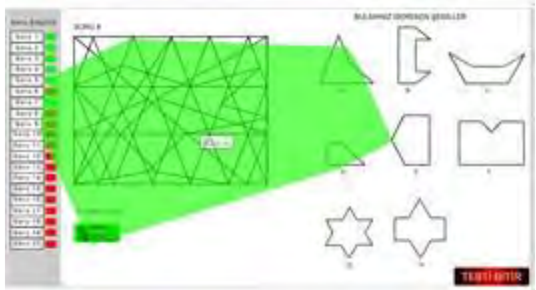
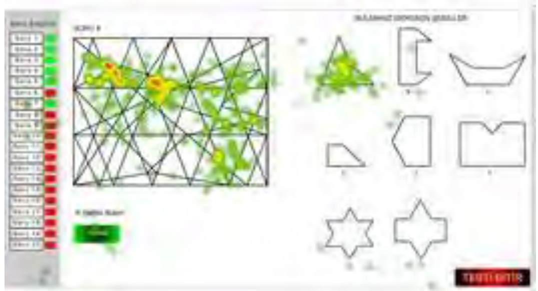
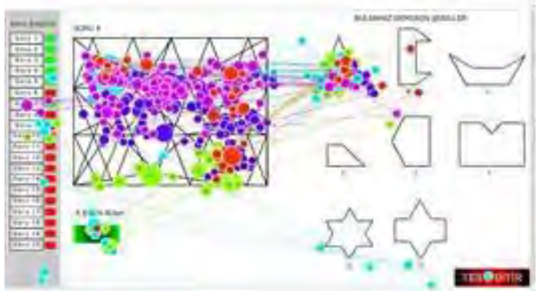
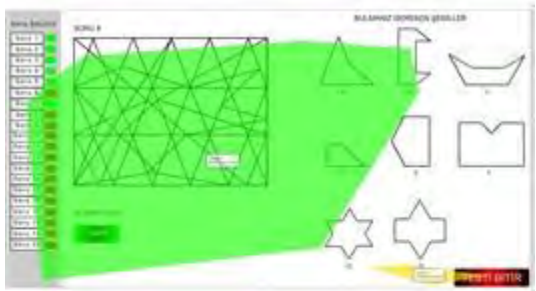
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	2			
		Male	-	-----	-----	-----
	Incorrect answer	Female	3			
		Male	5			

Table 38. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 9

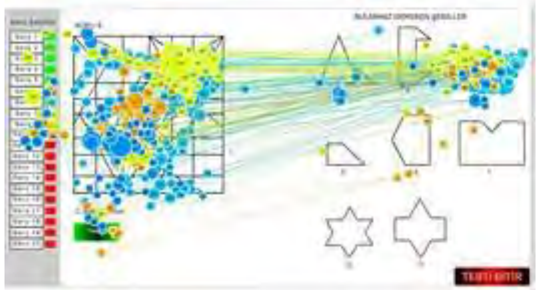
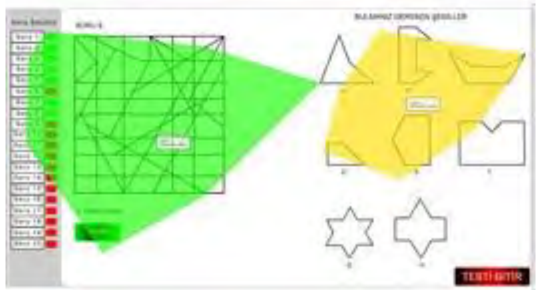
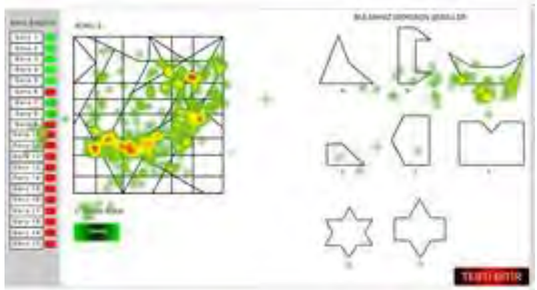
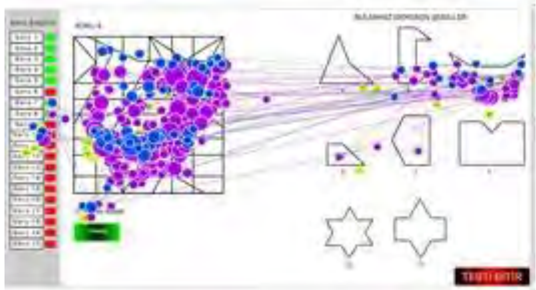
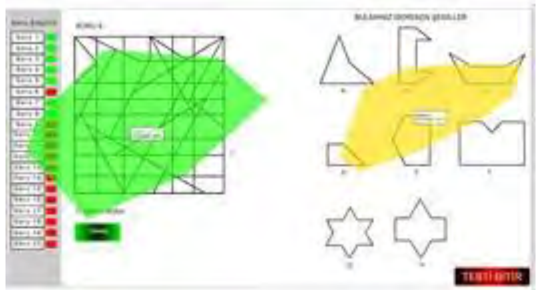
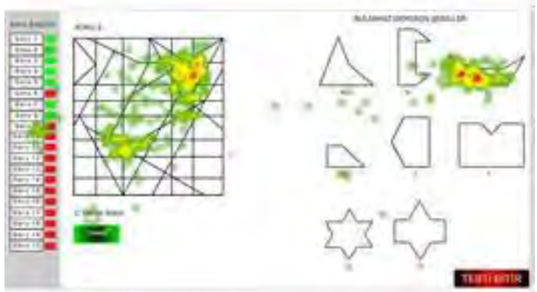
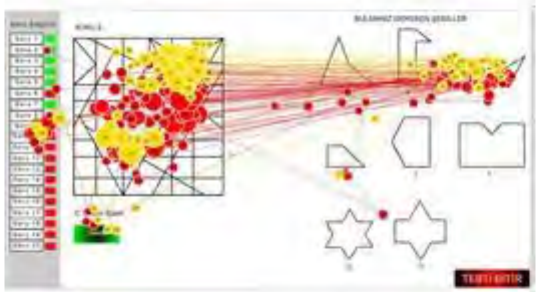
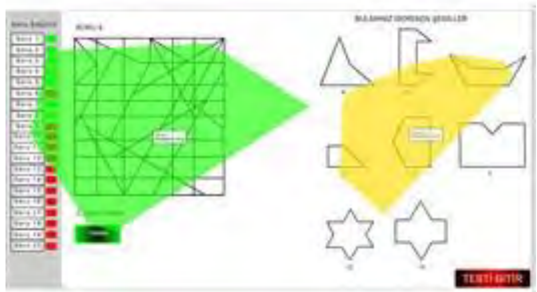
<table>
<tr><th colspan="3">Situation</th><th>N</th><th>Heatmap</th><th>Gaze plot</th><th>Cluster</th></tr>
<tr><td rowspan="4">Field Dependent</td><td rowspan="2">Correct answer</td><td>Female</td><td>5</td><td></td><td></td><td></td></tr>
<tr><td>Male</td><td>3</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Incorrect answer</td><td>Female</td><td>-</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>Male</td><td>2</td><td></td><td></td><td></td></tr>
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Table 39. Images of Field Independent Preservice Elementary Teachers' Answers to Question 9

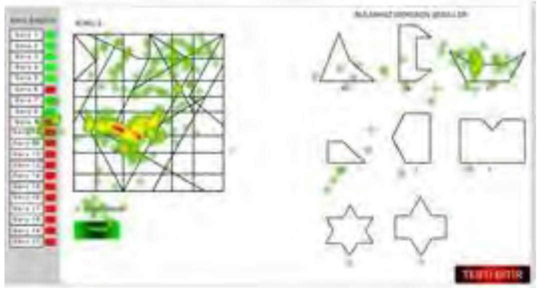
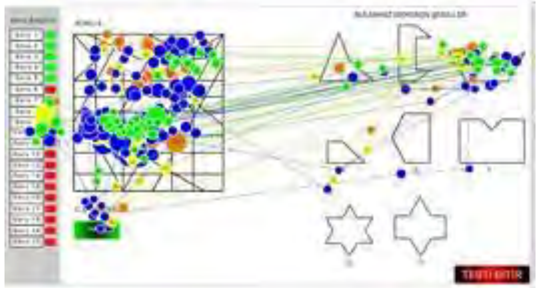
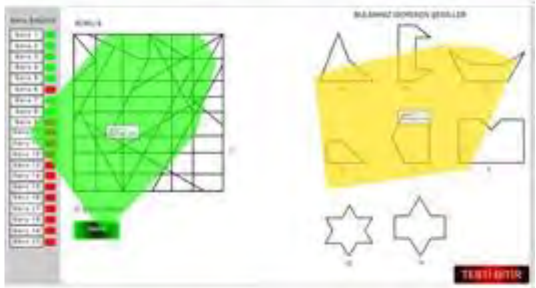
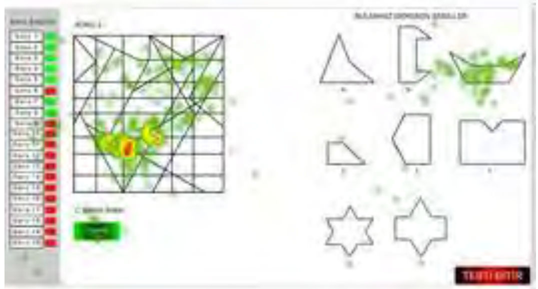
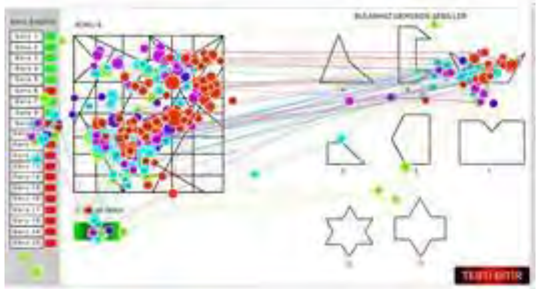
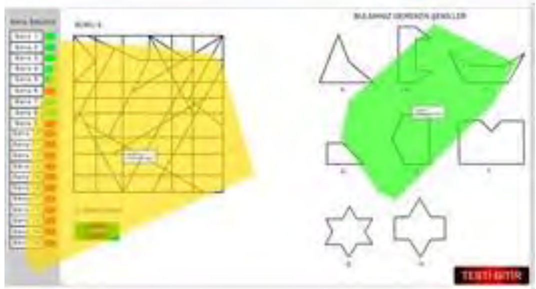
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	5			
		Male	5			
	Incorrect answer	Female	-	-----	-----	-----
		Male	-	-----	-----	-----

Table 40. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 10

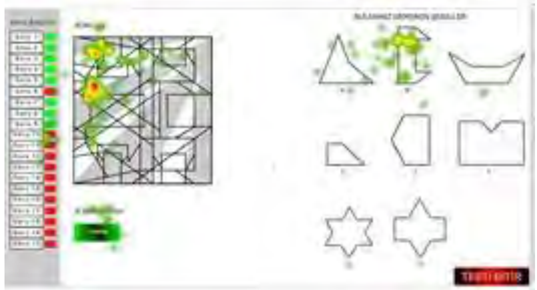
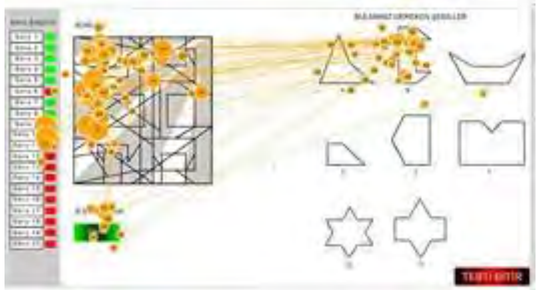
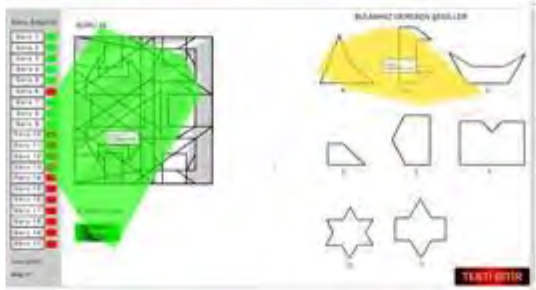
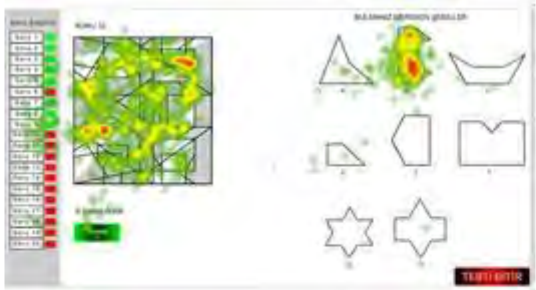
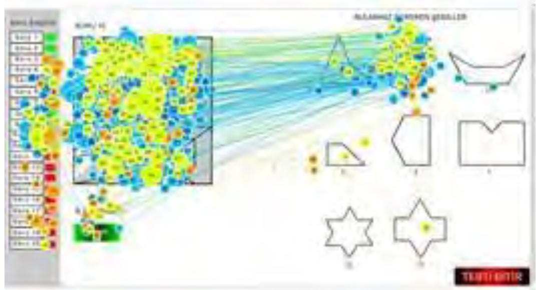
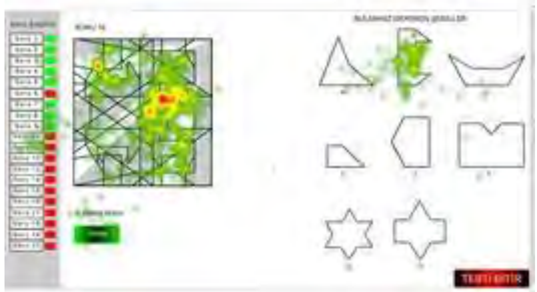
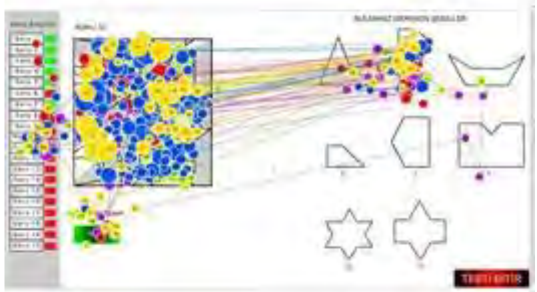
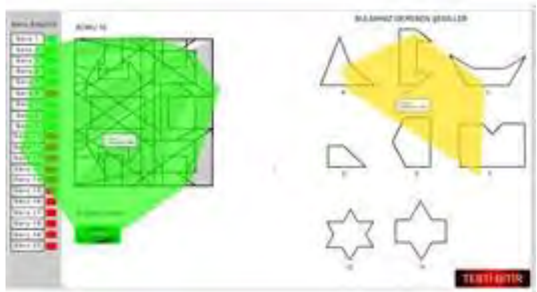
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	1			
		Male	-	-----	-----	-----
	Incorrect answer	Female	4			
		Male	5			

Table 41. Images of Field Independent Preservice Elementary Teachers' Answers to Question 10

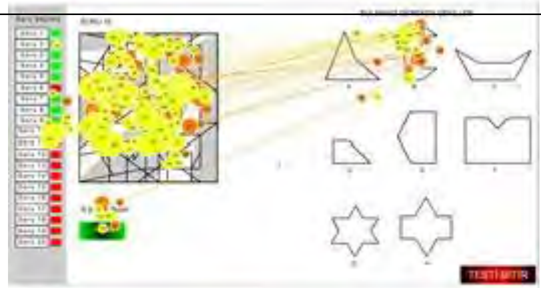
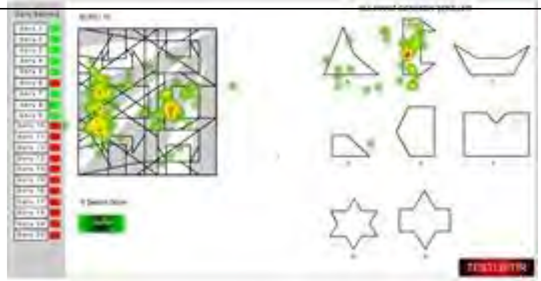
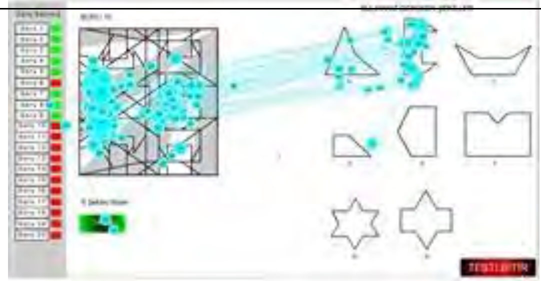
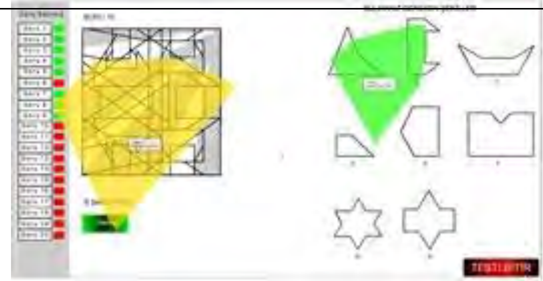
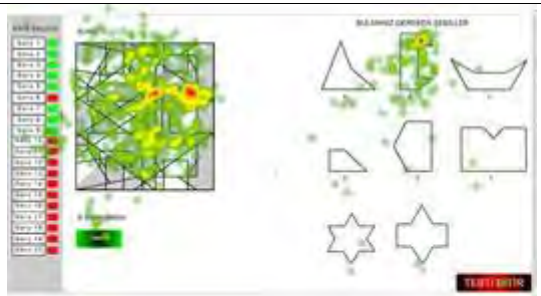
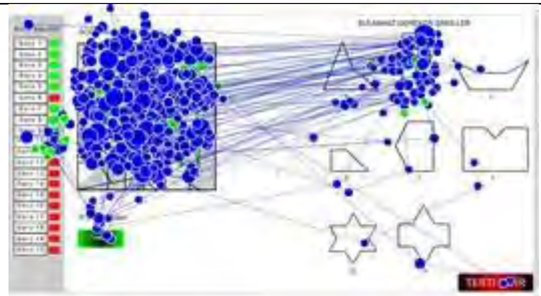
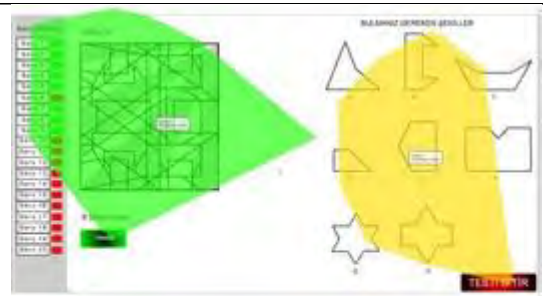
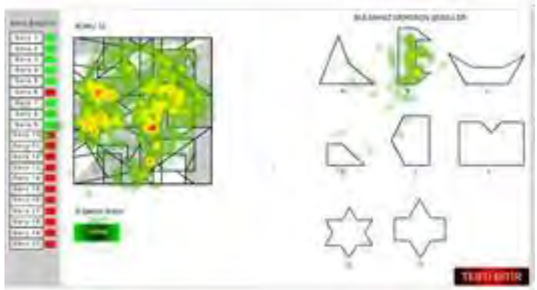
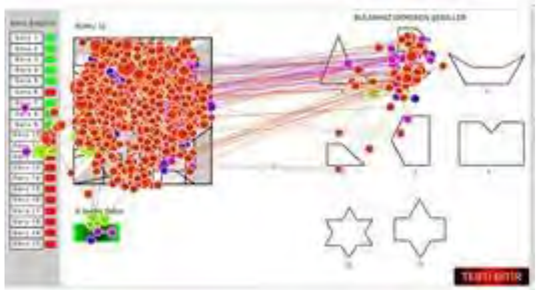
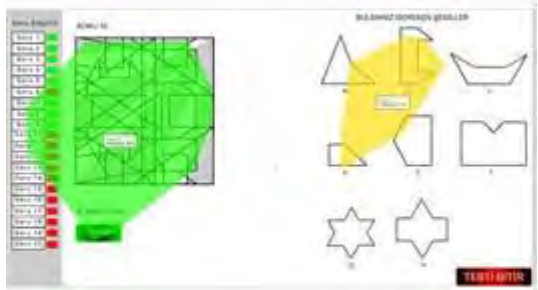
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	2			
		Male	1			
	Incorrect answer	Female	3			
		Male	4			

Table 42. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 11

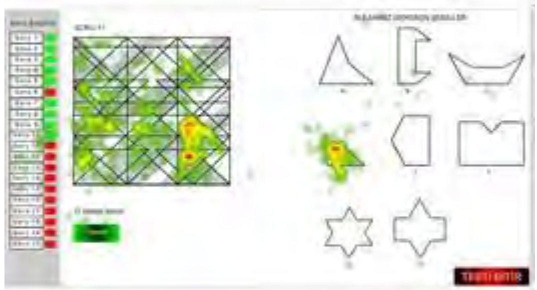
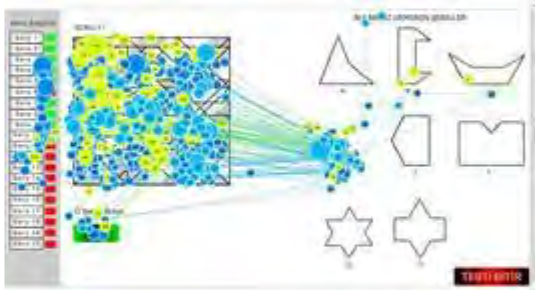
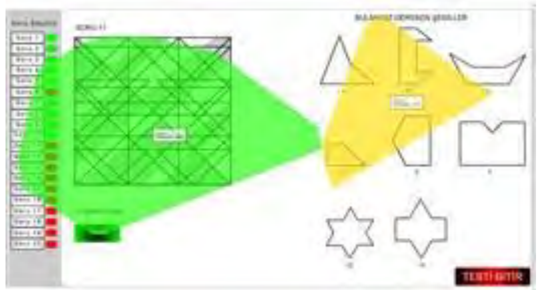
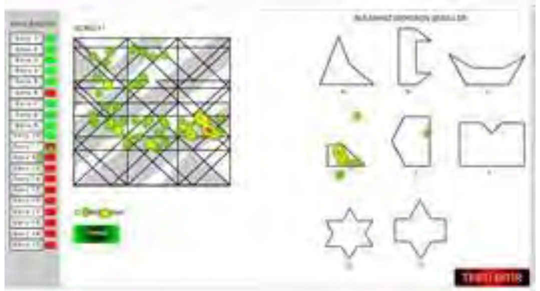
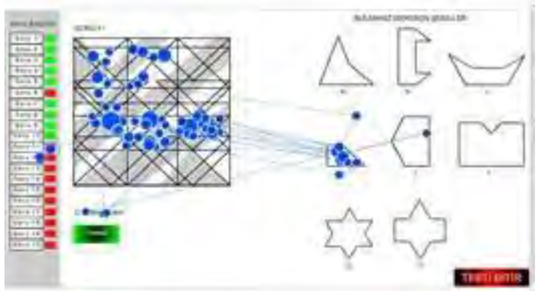
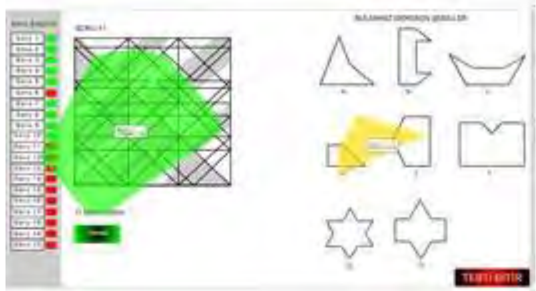
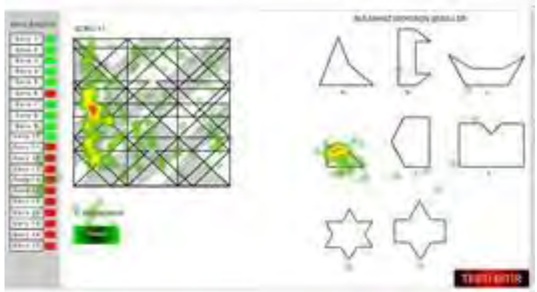
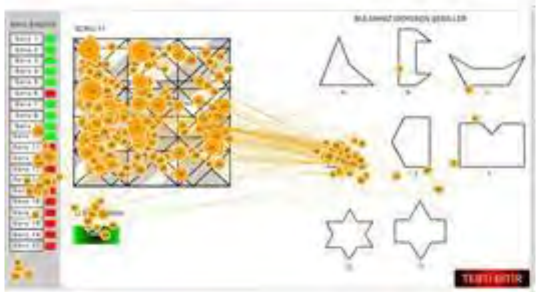
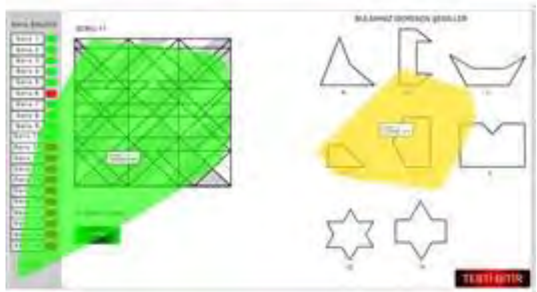
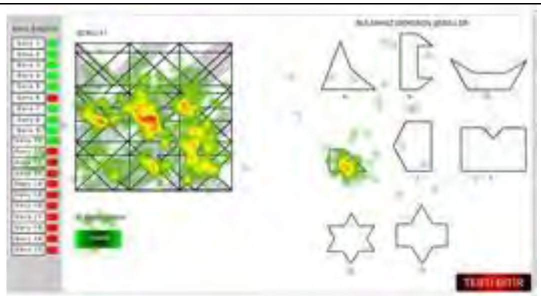
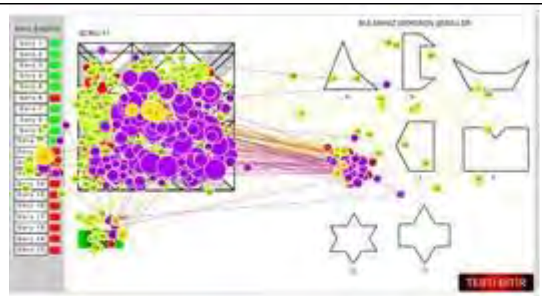
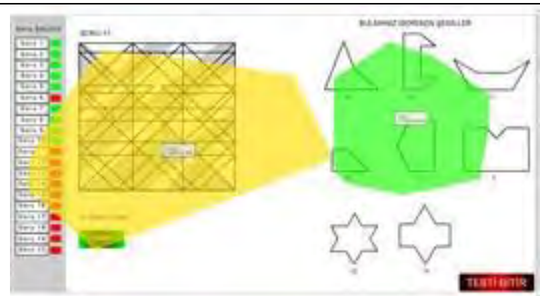
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	3			
		Male	1			
	Incorrect answer	Female	2			
		Male	4			

Table 43. Images of Field Independent Preservice Elementary Teachers' Answers to Question 11

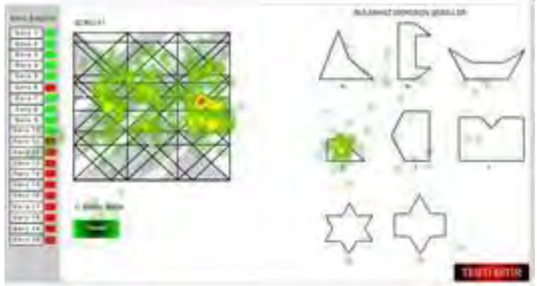
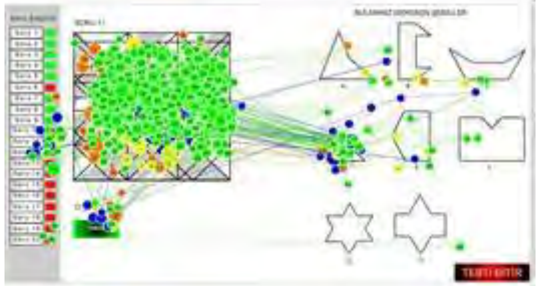
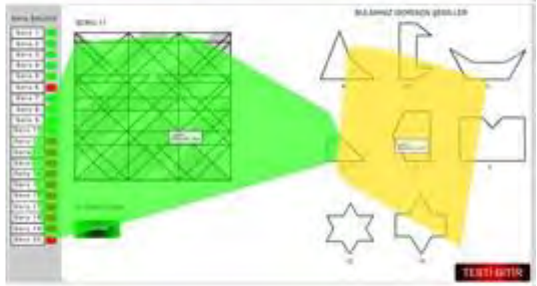
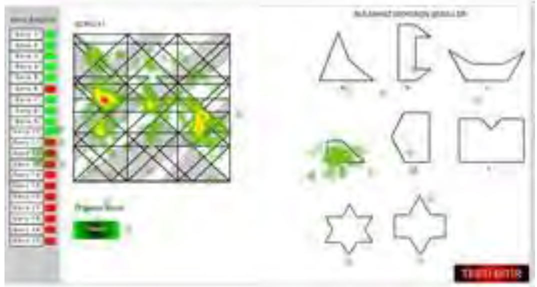
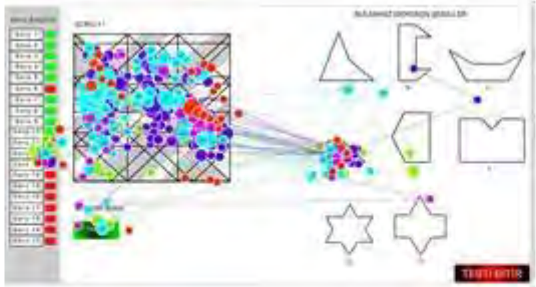
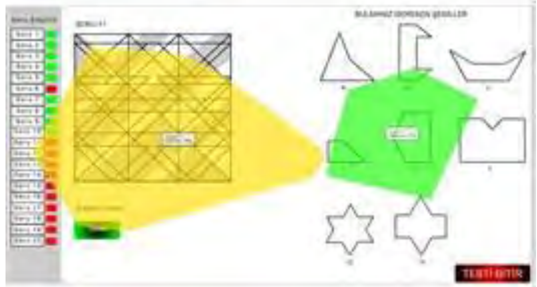
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	5			
		Male	5			
	Incorrect answer	Female	-	-----	-----	-----
		Male	-	-----	-----	-----

Table 44. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 12

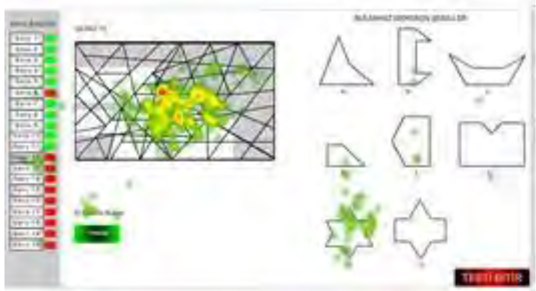
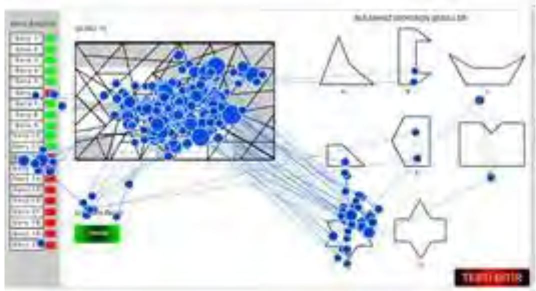
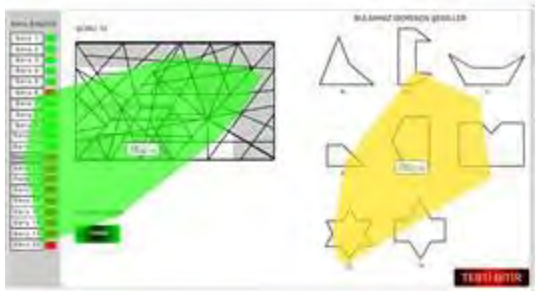
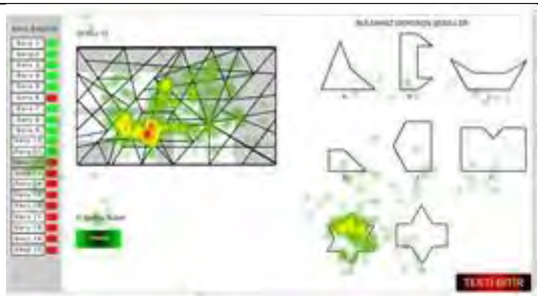
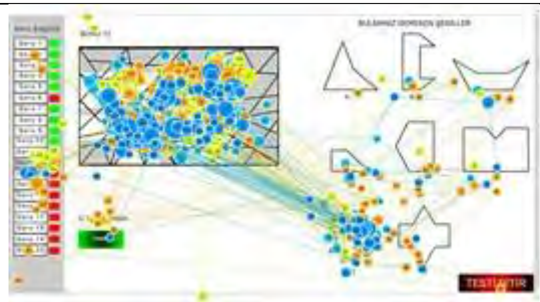
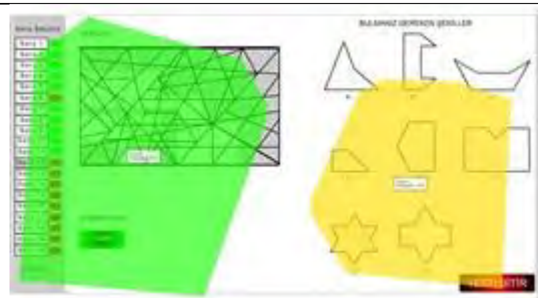
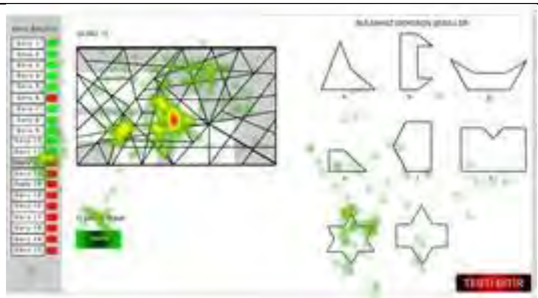
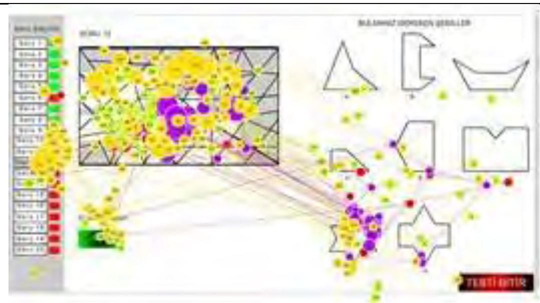
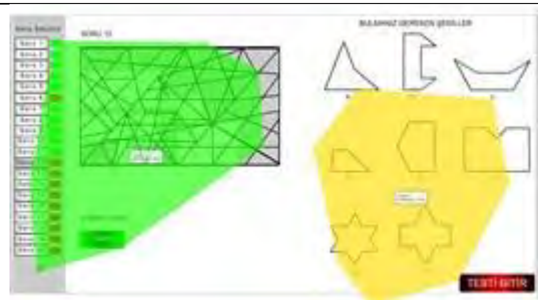
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	-	-----	-----	-----
		Male	1			
	Incorrect answer	Female	5			
		Male	4			

Table 45. Images of Field Independent Preservice Elementary Teachers' Answers to Question 12

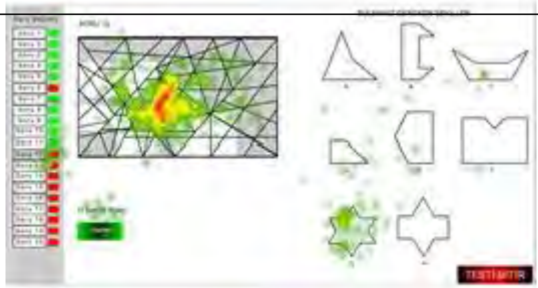
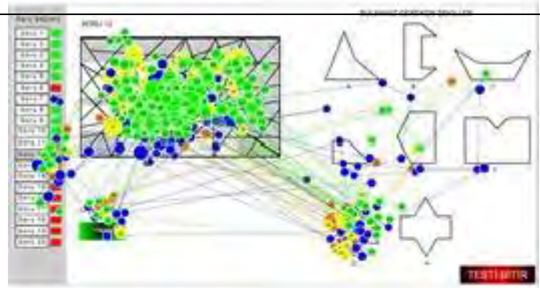
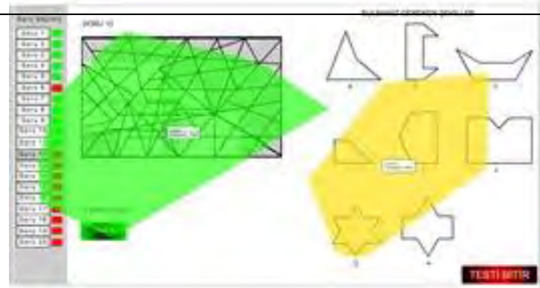
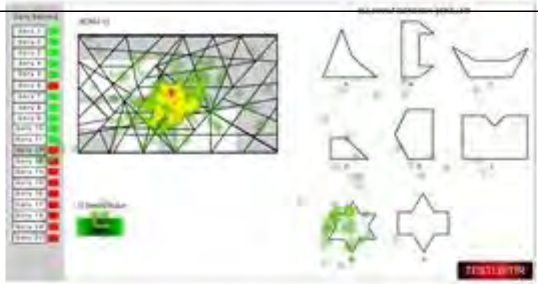
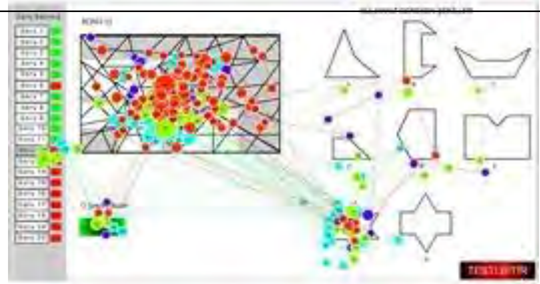
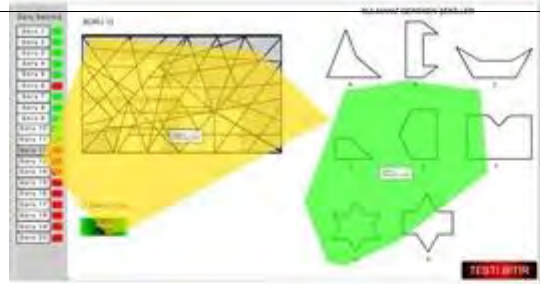
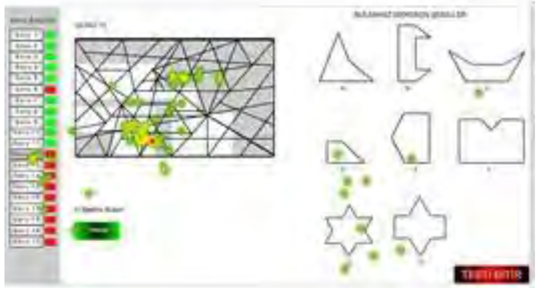
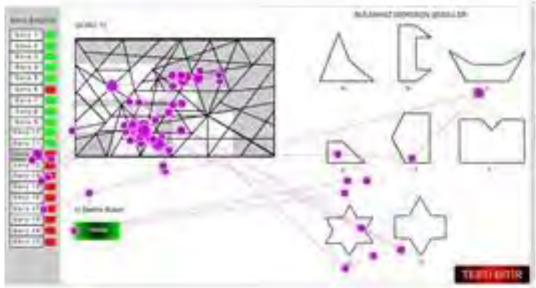
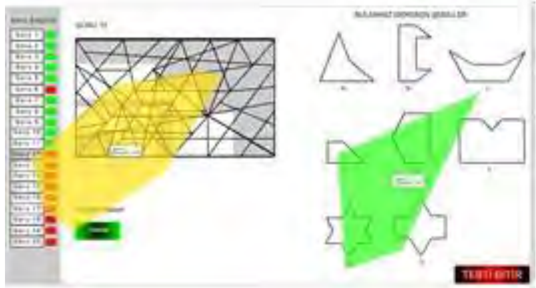
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	5			
		Male	4			
	Incorrect answer	Female	-	-----	-----	-----
		Male	1			

Table 46. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 13

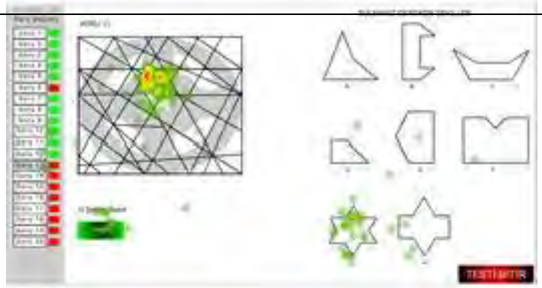
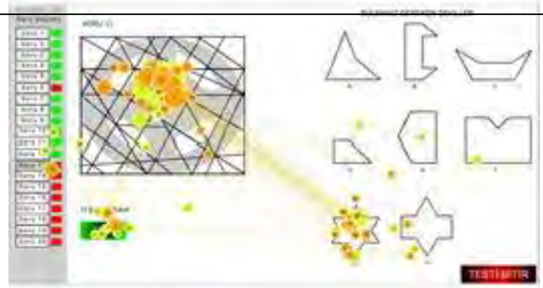
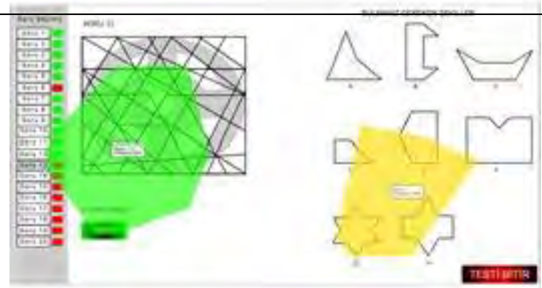
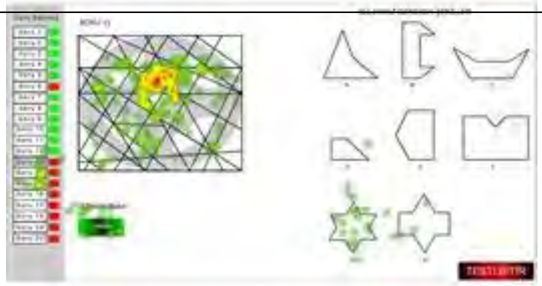
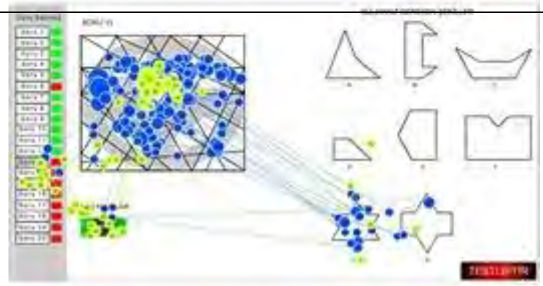
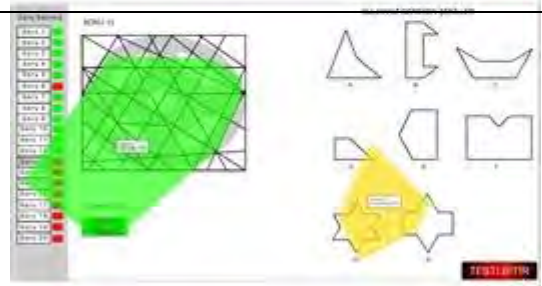
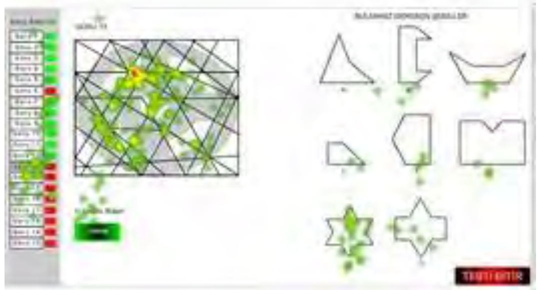
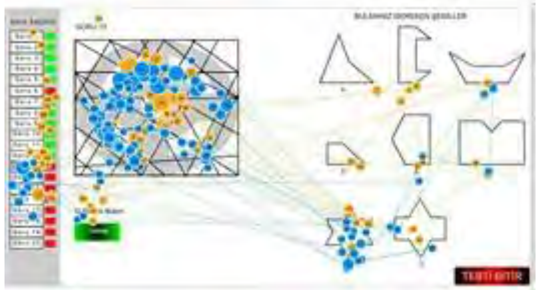
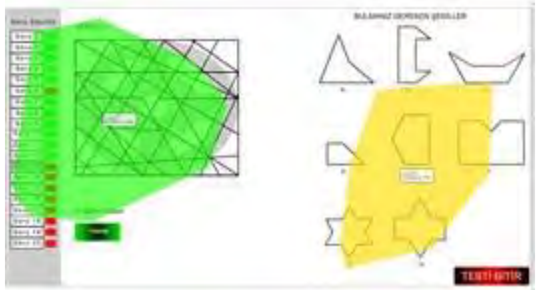
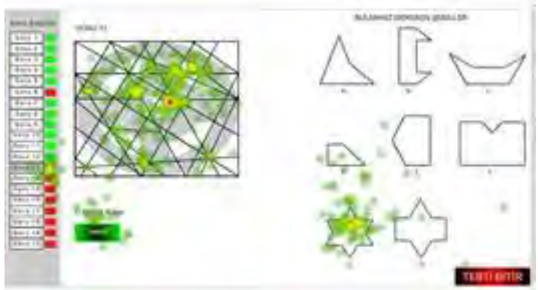
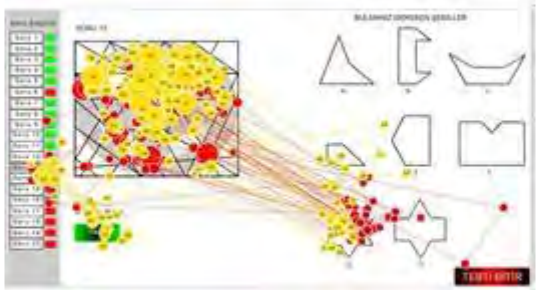
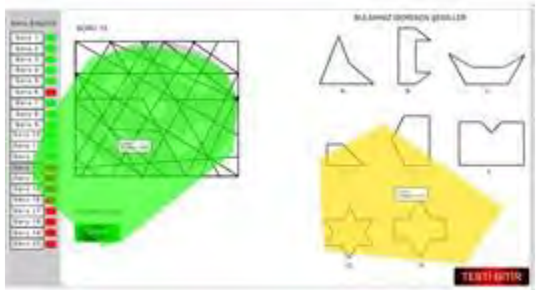
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	2			
		Male	2			
	Incorrect answer	Female	2			
		Male	2			

Table 47. Images of Field Independent Preservice Elementary Teachers' Answers to Question 13

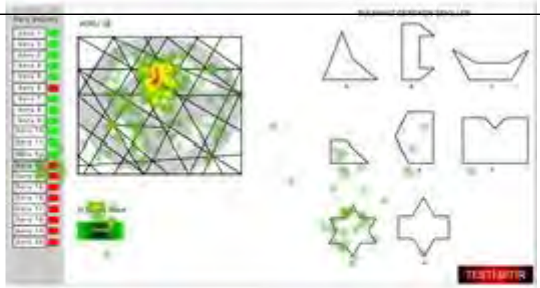
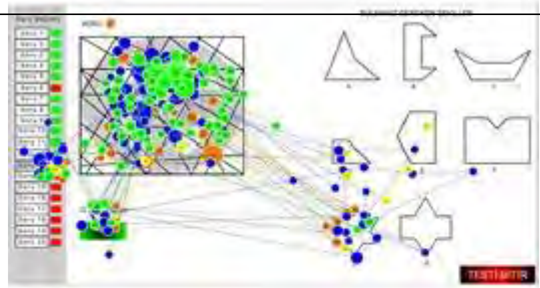
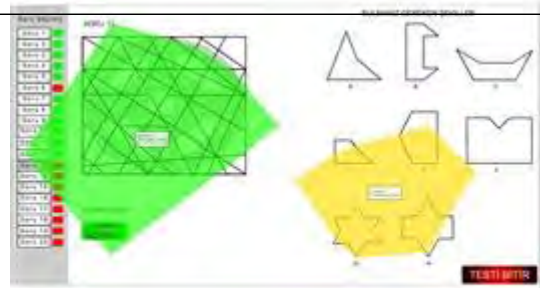
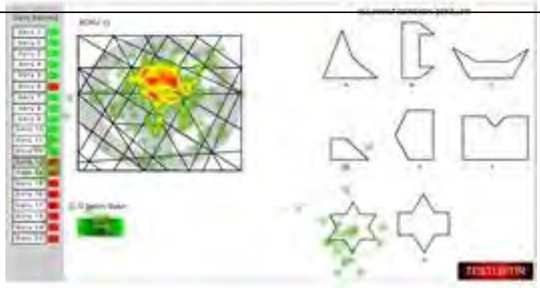
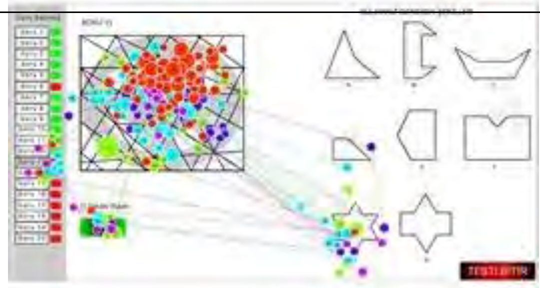
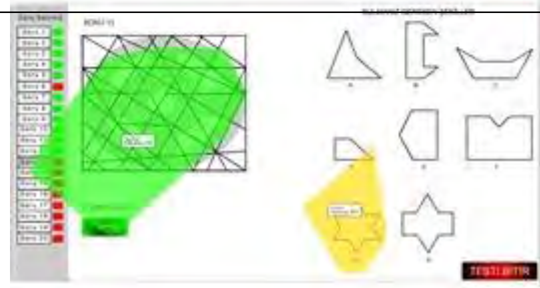
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	5			
		Male	5			
	Incorrect answer	Female	-	-----	-----	-----
		Male	-	-----	-----	-----

Table 48. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 14

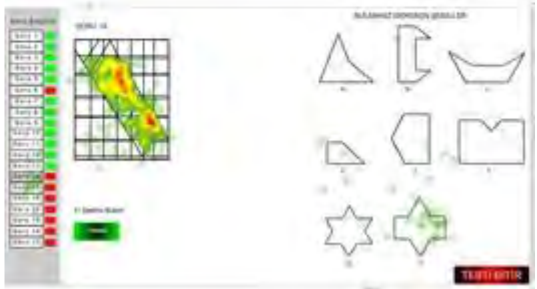
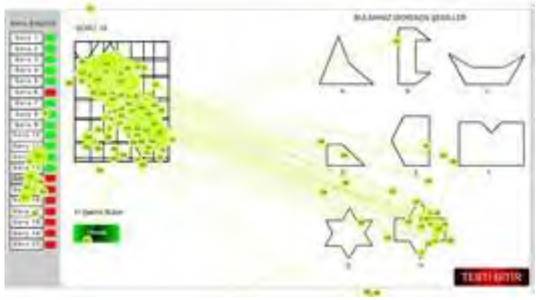
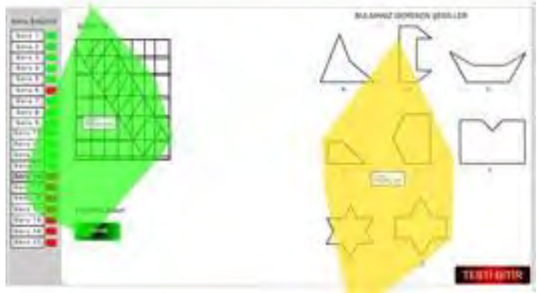
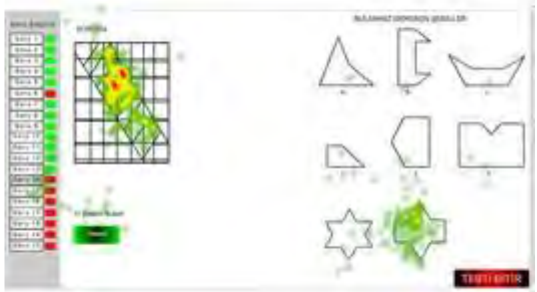
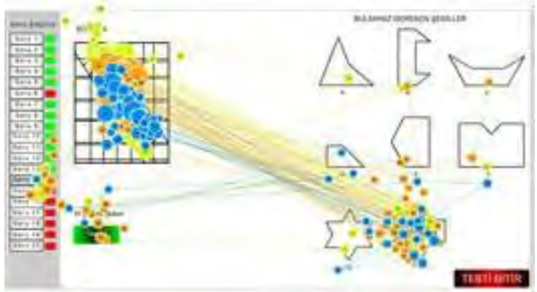
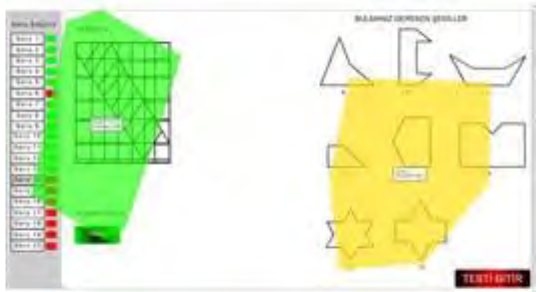
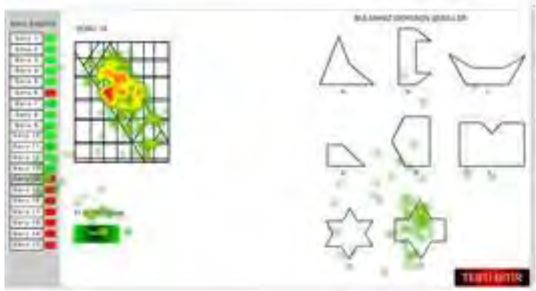
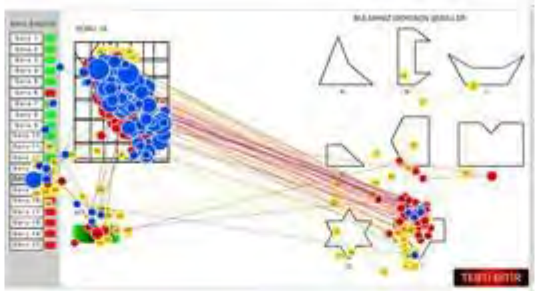
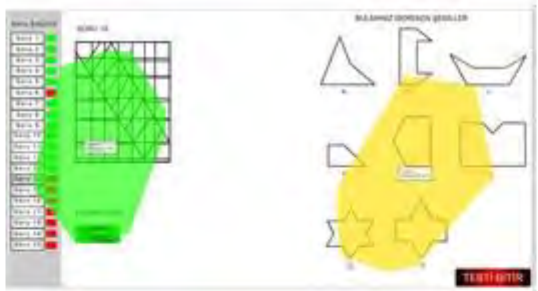
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	-	-----	-----	-----
		Male	1			
	Incorrect answer	Female	4			
		Male	3			

Table 49. Images of Field Independent Preservice Elementary Teachers' Answers to Question 14

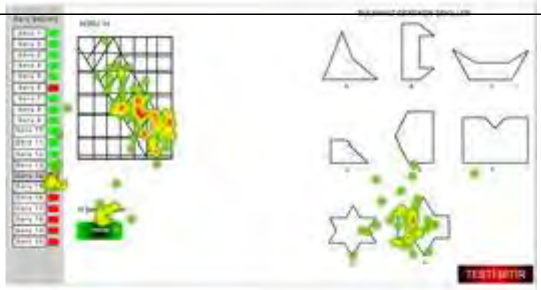
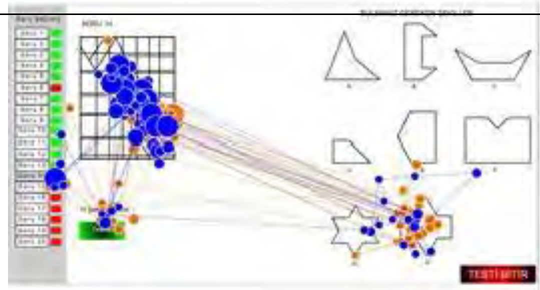
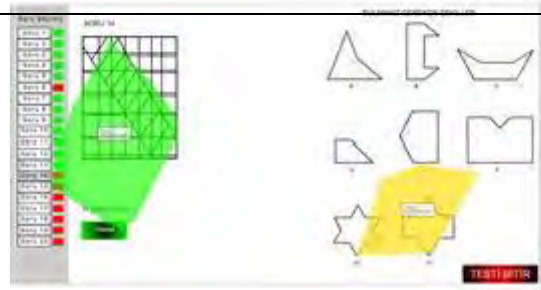
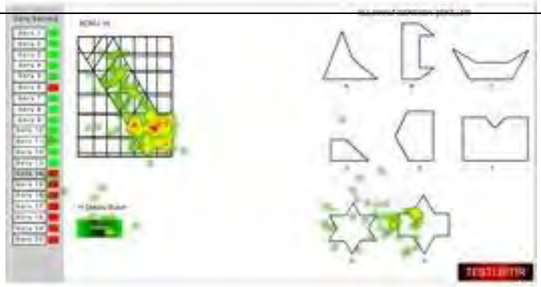
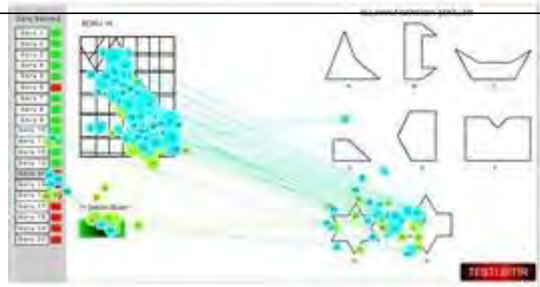
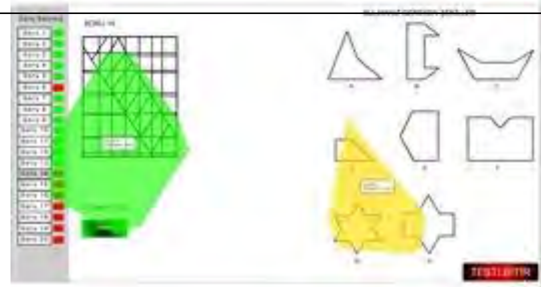
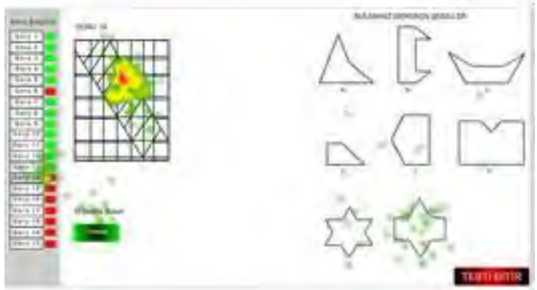
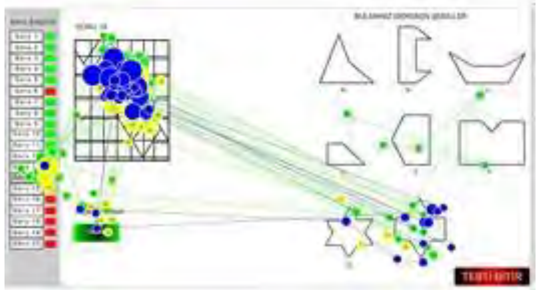
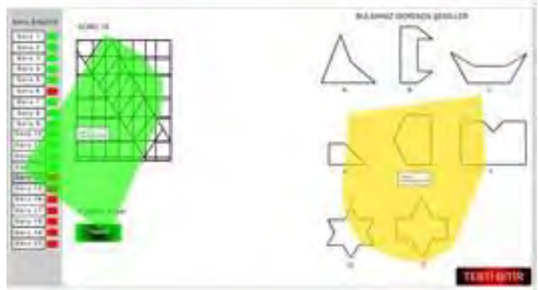
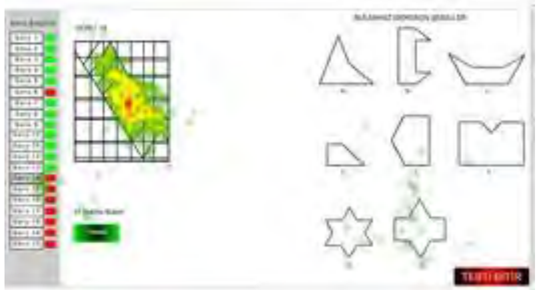
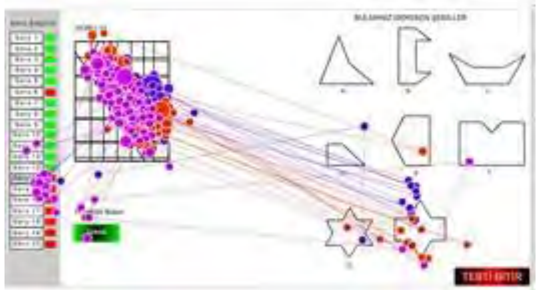
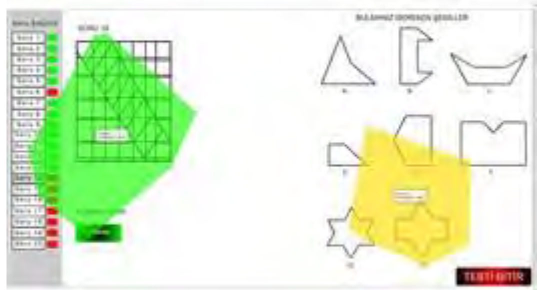
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	2			
		Male	2			
	Incorrect answer	Female	3			
		Male	3			

Table 50. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 15

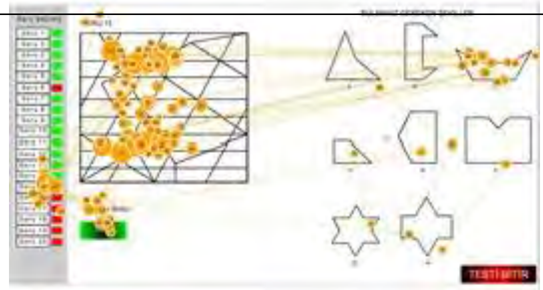
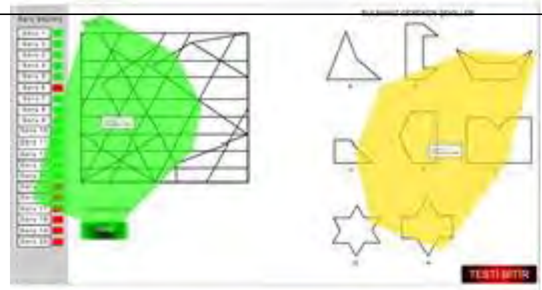
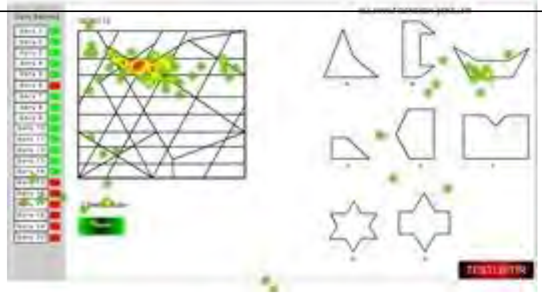
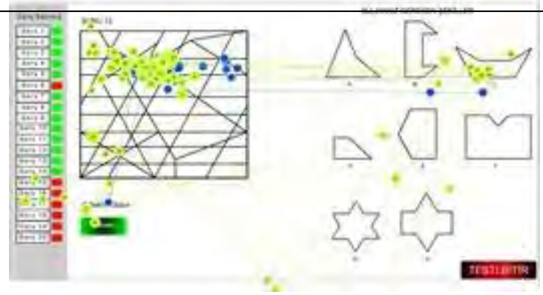
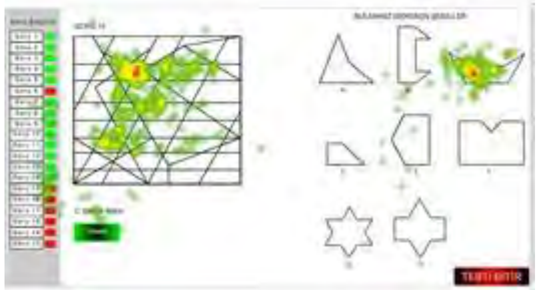
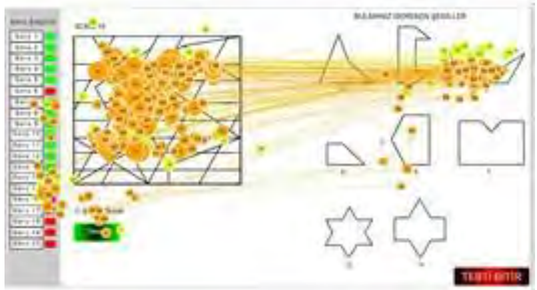
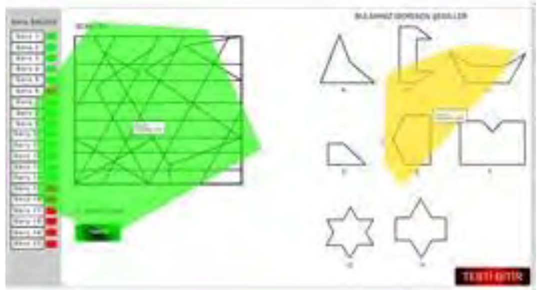
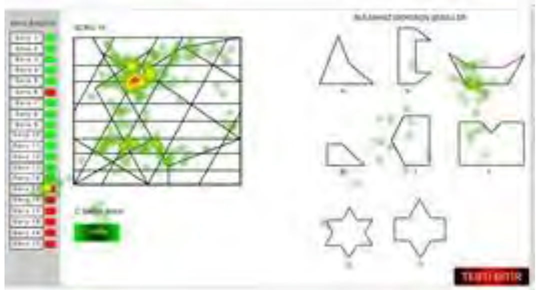
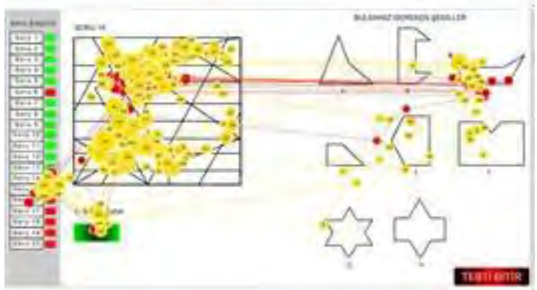
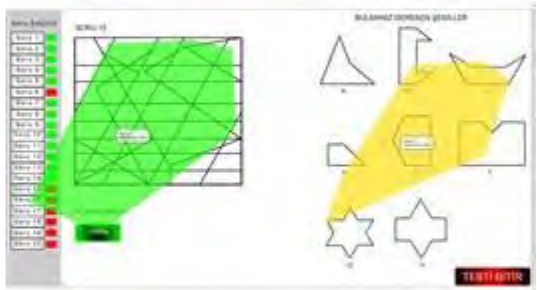
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	1			
		Male	2			
	Incorrect answer	Female	2			
		Male	2			

Table 51. Images of Field Independent Preservice Elementary Teachers' Answers to Question 15

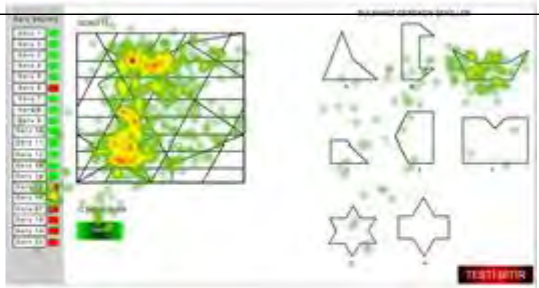
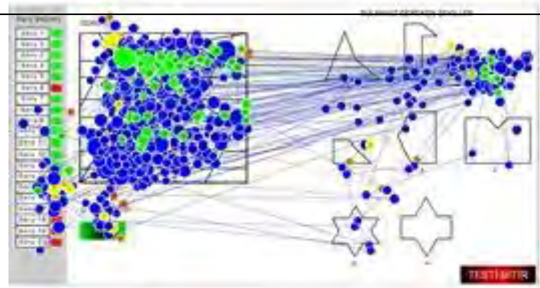
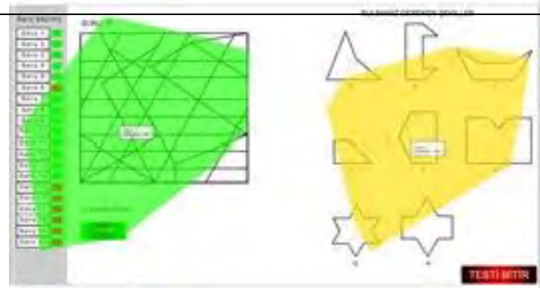
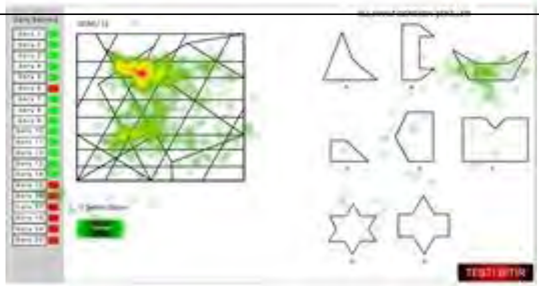
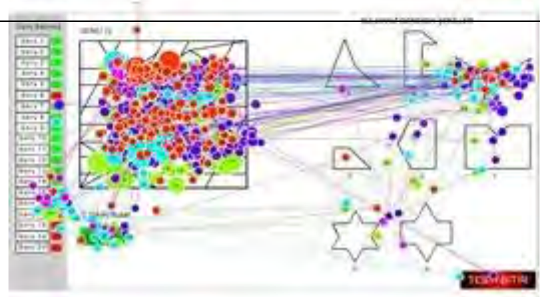
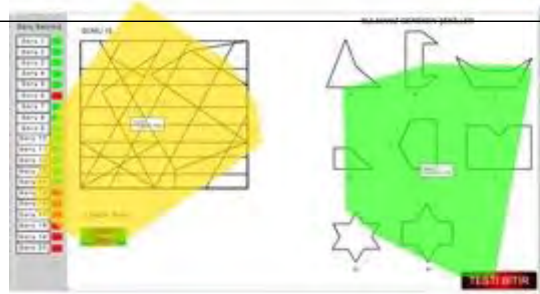
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	5			
		Male	5			
	Incorrect answer	Female	-	-----	-----	-----
		Male	-	-----	-----	-----

Table 52. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 16

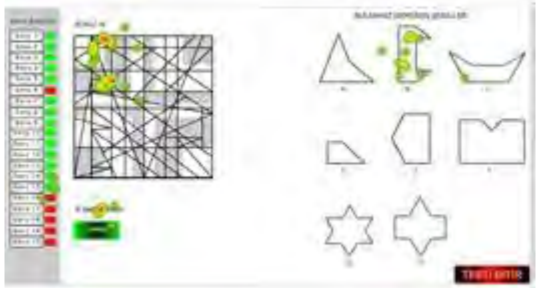
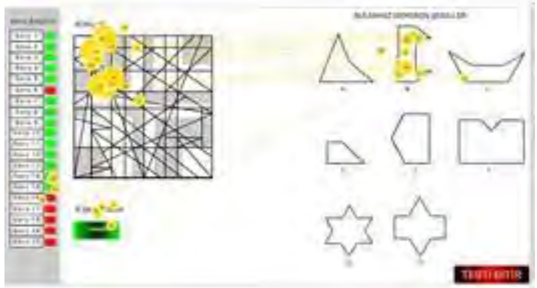
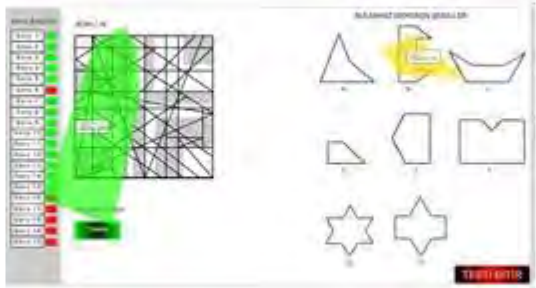
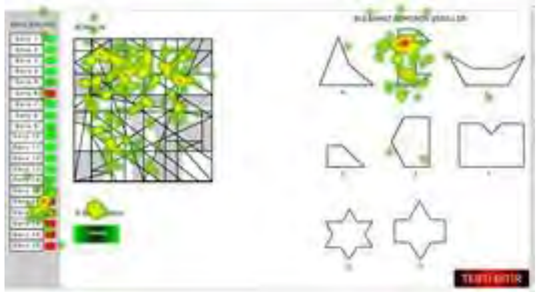
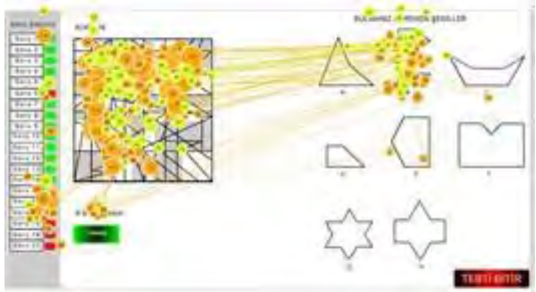
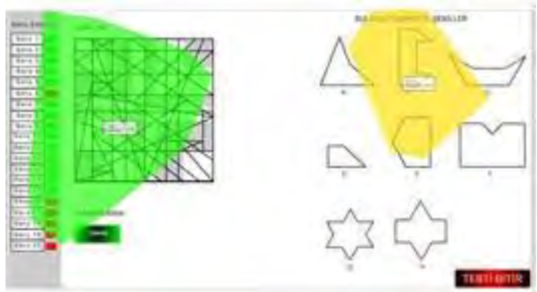
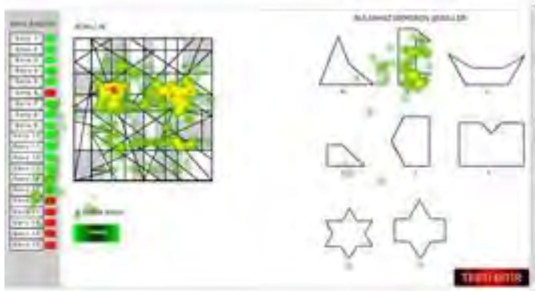
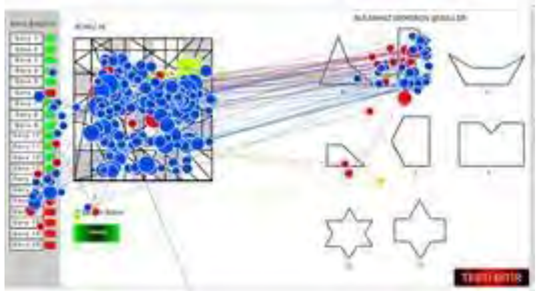
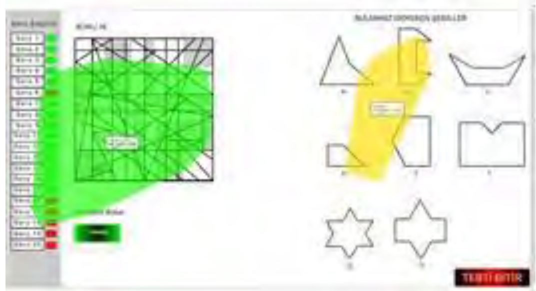
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	-	-----	-----	-----
		Male	1			
	Incorrect answer	Female	3			
		Male	3			

Table 53. Images of Field Independent Preservice Elementary Teachers' Answers to Question 16

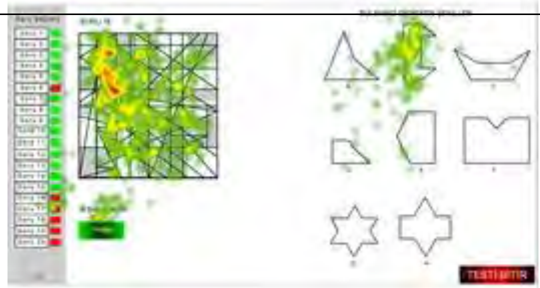
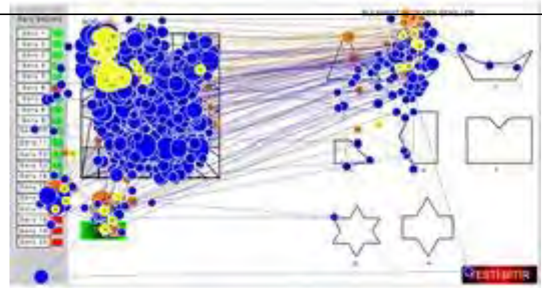
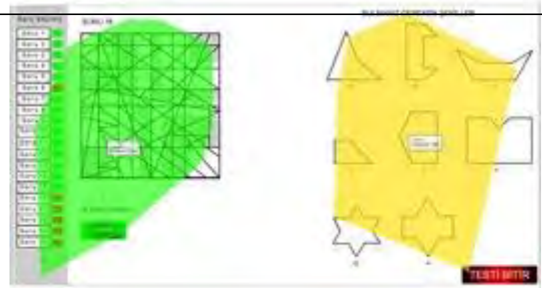
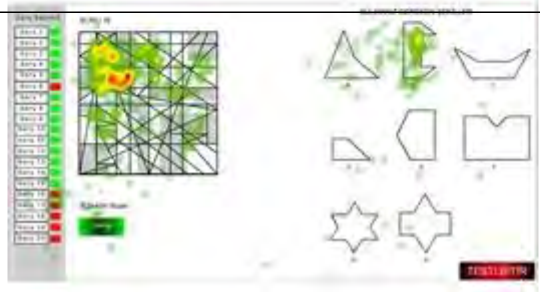
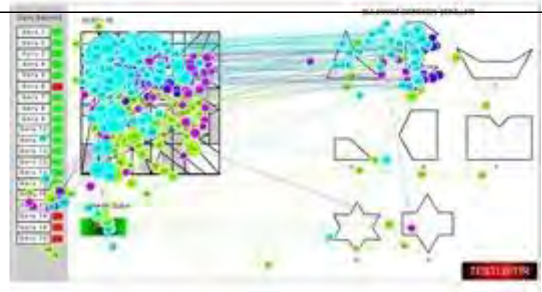
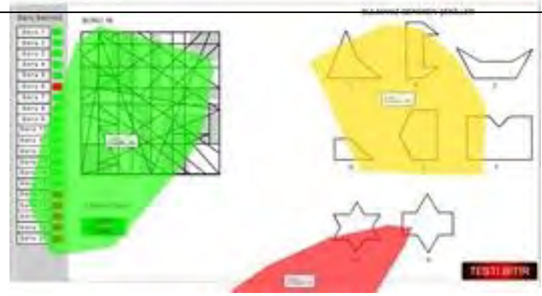
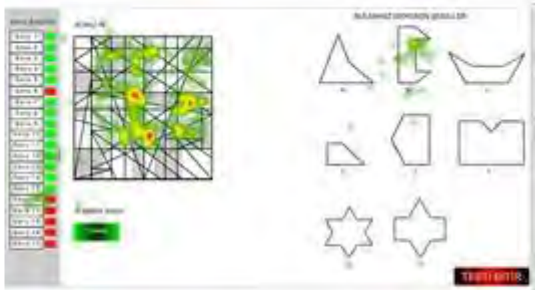
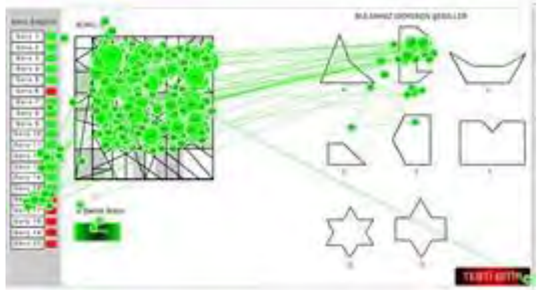
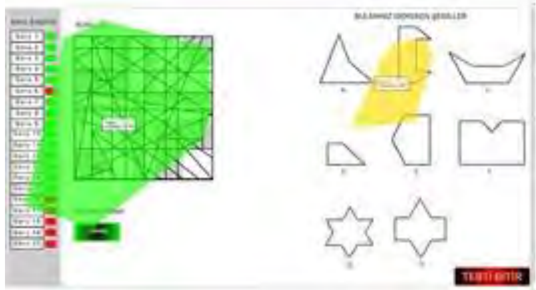
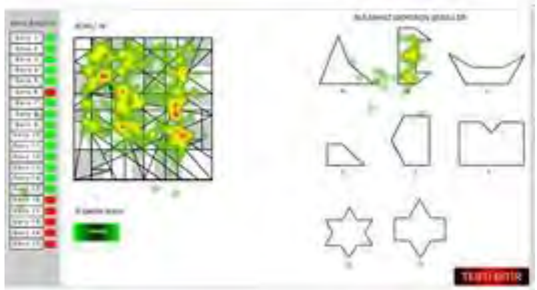
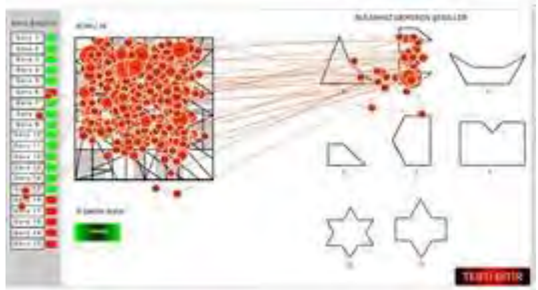
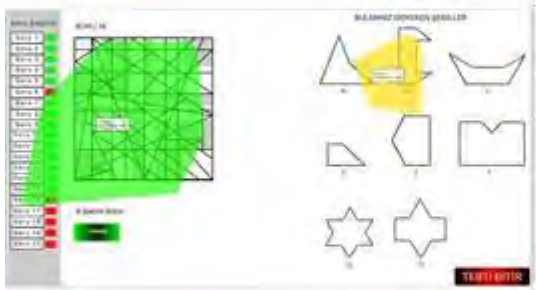
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	4			
		Male	4			
	Incorrect answer	Female	1			
		Male	1			

Table 54. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 17

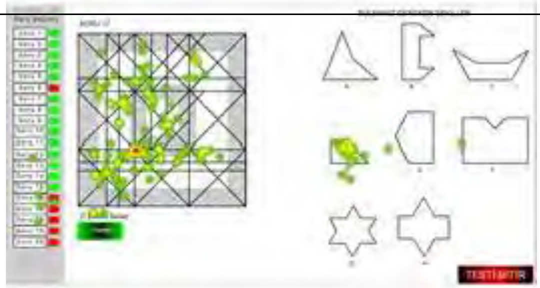
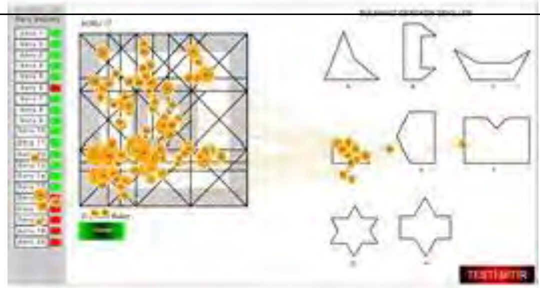
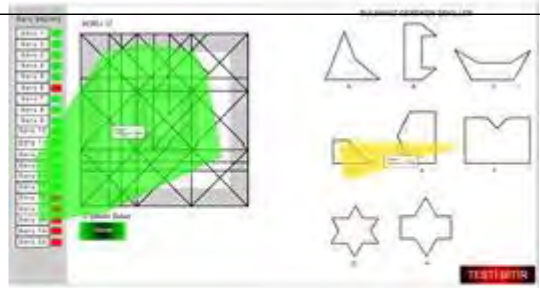
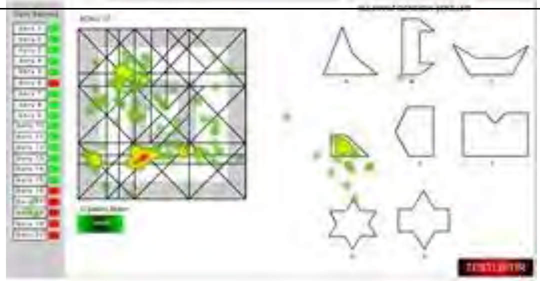
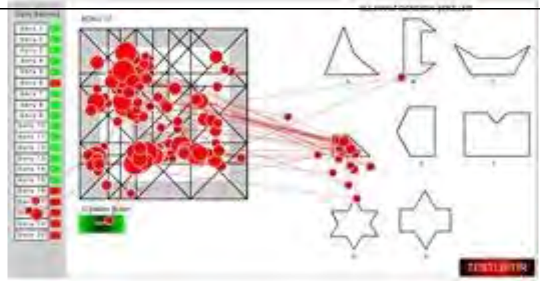
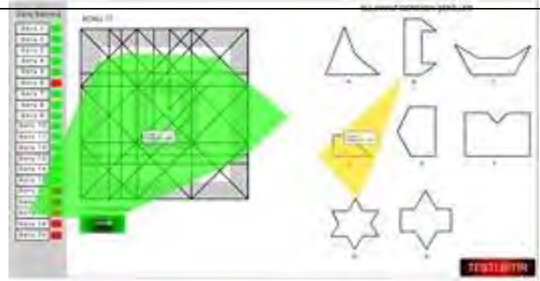
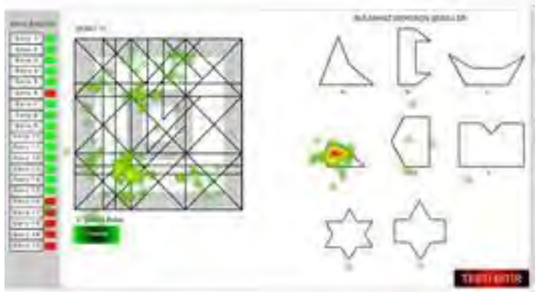
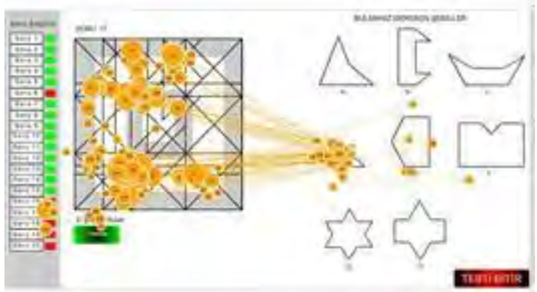
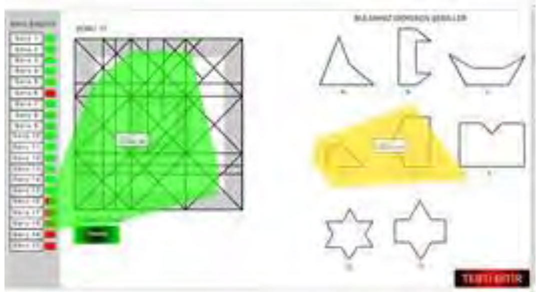
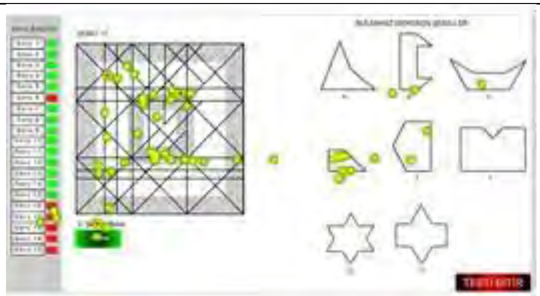
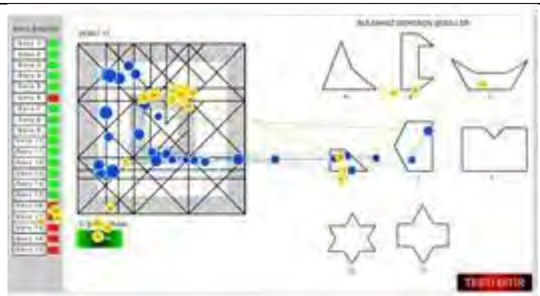
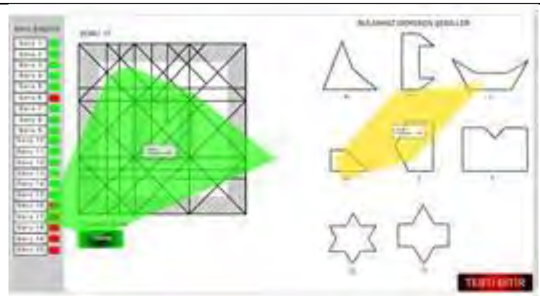
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	1			
		Male	1			
	Incorrect answer	Female	1			
		Male	2			

Table 55. Images of Field Independent Preservice Elementary Teachers' Answers to Question 17

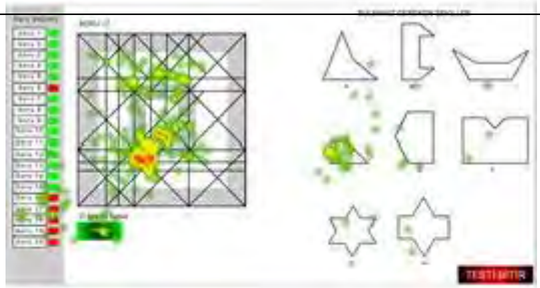
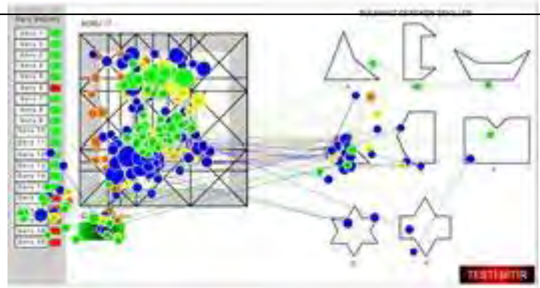
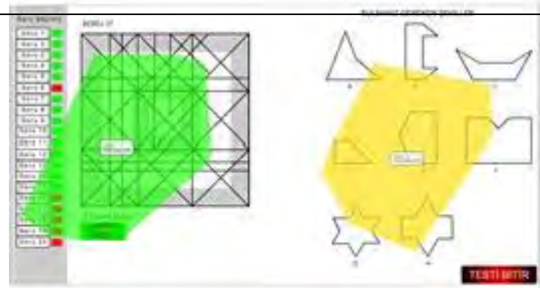
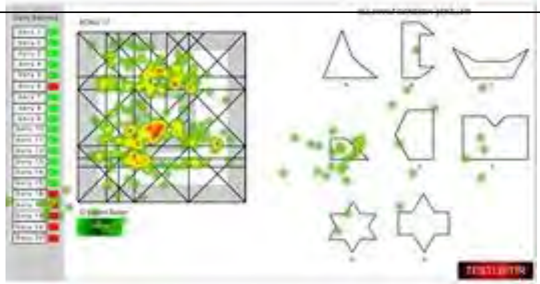
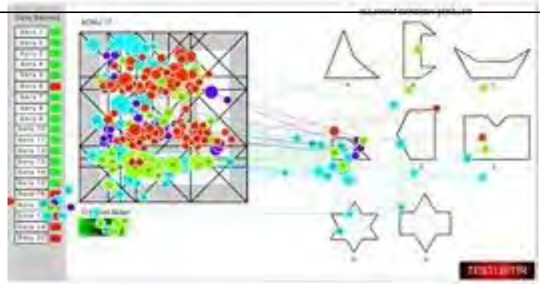
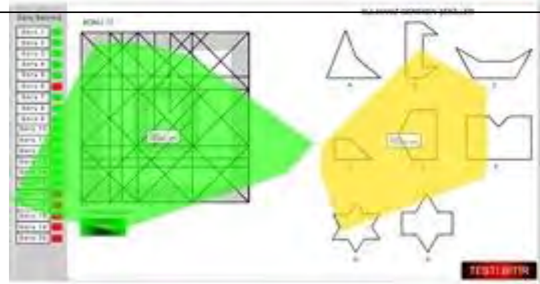
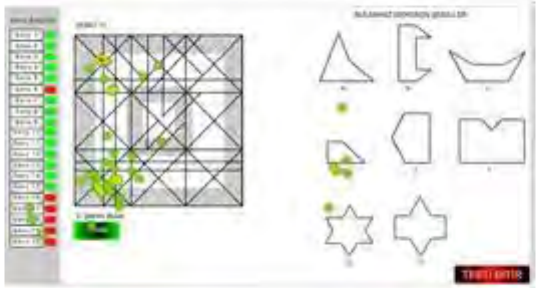
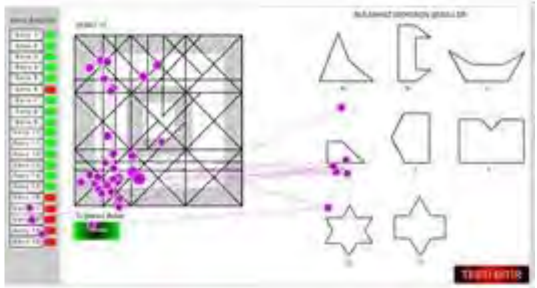
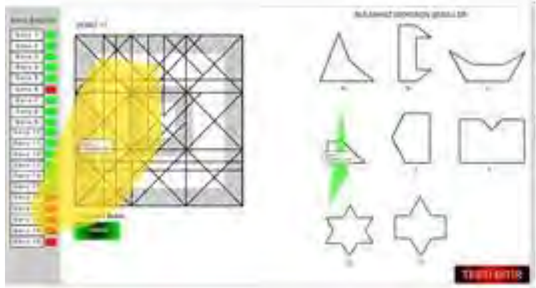
<table>
<tr><th colspan="3">Situation</th><th>N</th><th>Heatmap</th><th>Gaze plot</th><th>Cluster</th></tr>
<tr><td rowspan="4">Field Independent</td><td rowspan="2">Correct answer</td><td>Female</td><td>5</td><td></td><td></td><td></td></tr>
<tr><td>Male</td><td>4</td><td></td><td></td><td></td></tr>
<tr><td rowspan="2">Incorrect answer</td><td>Female</td><td>-</td><td>-----</td><td>-----</td><td>-----</td></tr>
<tr><td>Male</td><td>1</td><td></td><td></td><td></td></tr>
</table>

Table 56. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 18

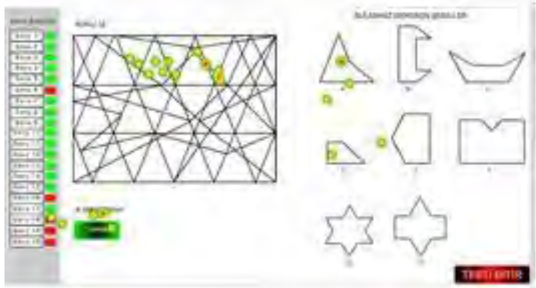
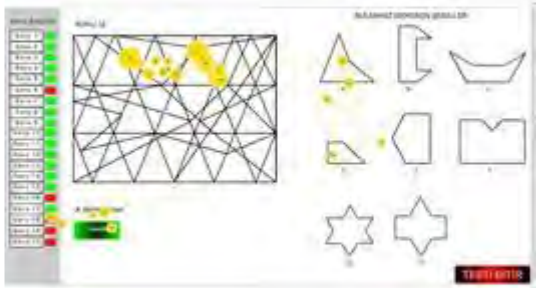
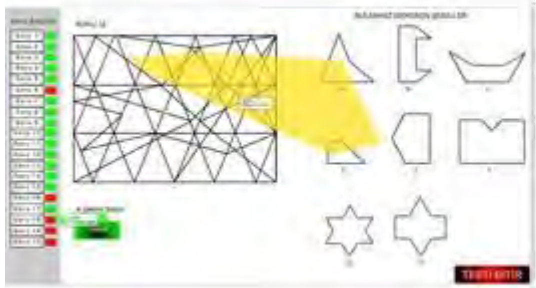
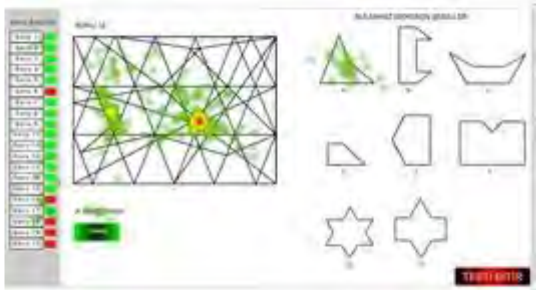
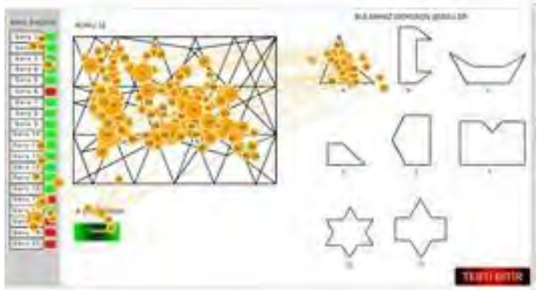
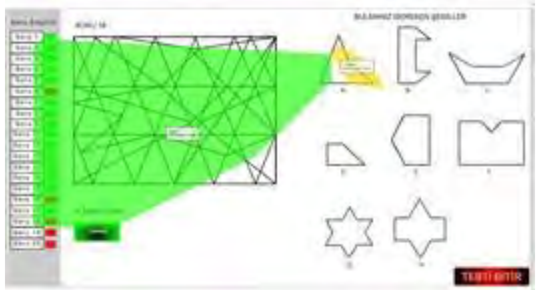
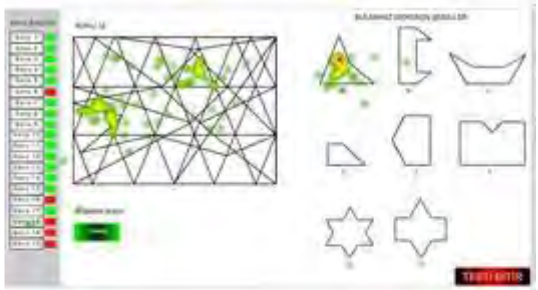
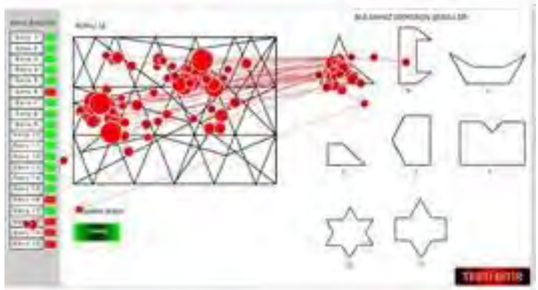
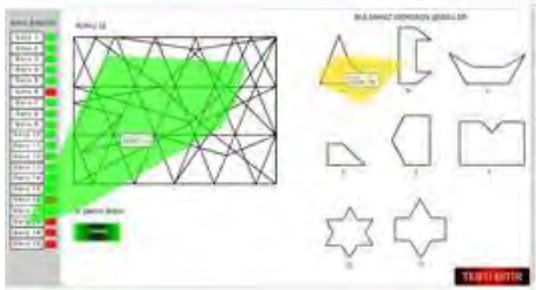
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	-	-----	-----	-----
		Male	1			
	Incorrect answer	Female	2			
		Male	1			

Table 57. Images of Field Independent Preservice Elementary Teachers' Answers to Question 18

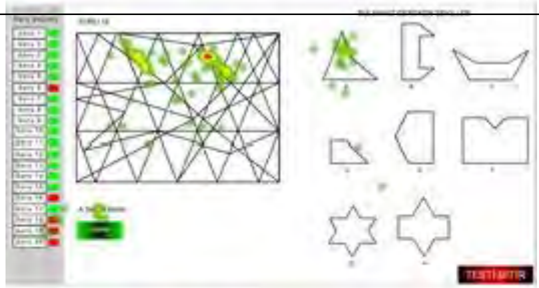
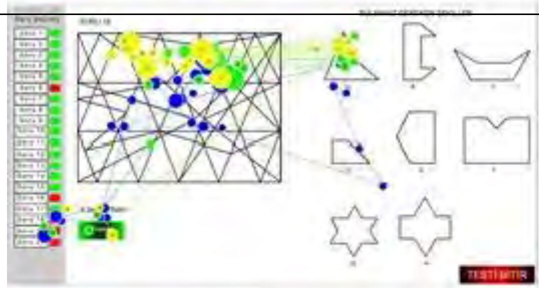
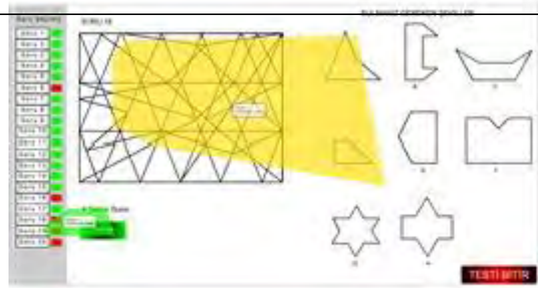
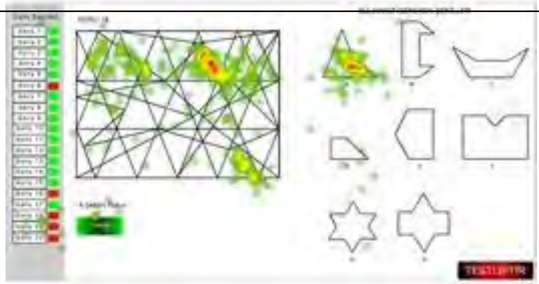
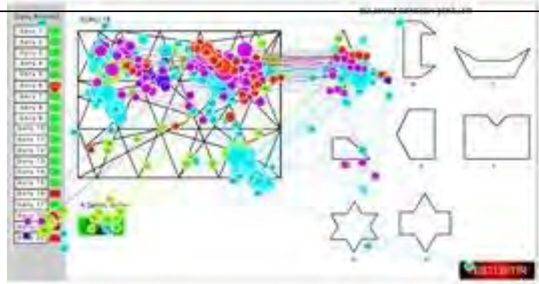
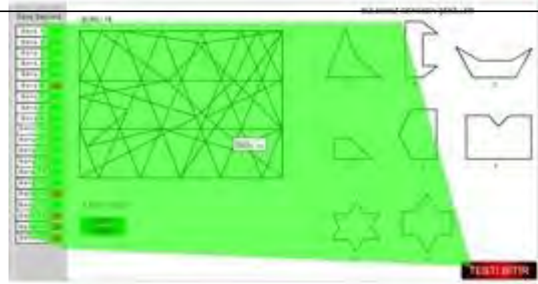
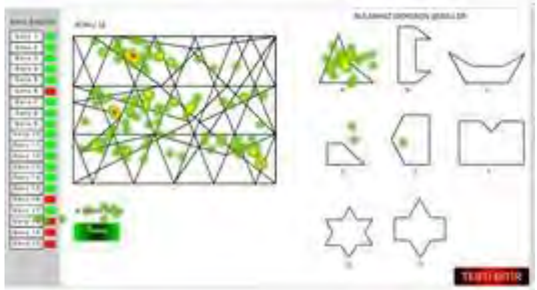
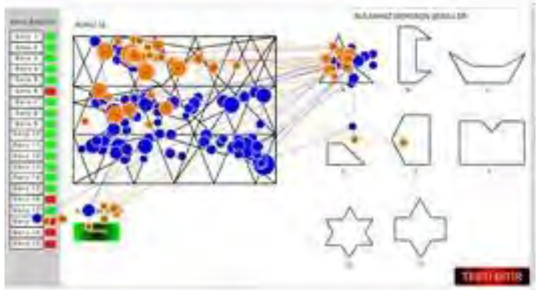
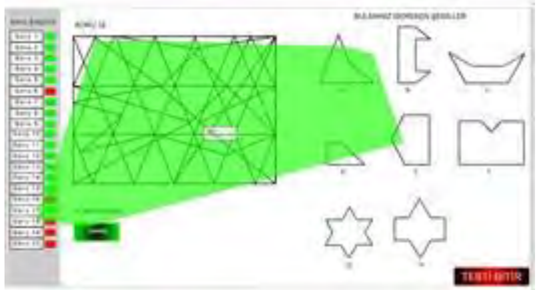
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	3			
		Male	5			
	Incorrect answer	Female	2			
		Male	-	-----	-----	-----

Table 58. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 19

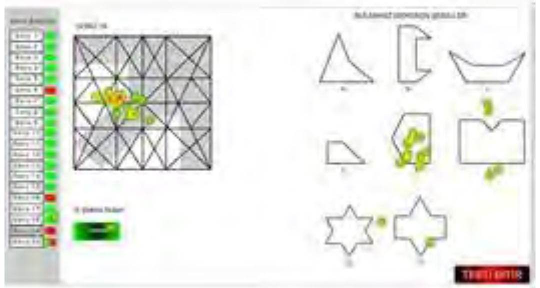
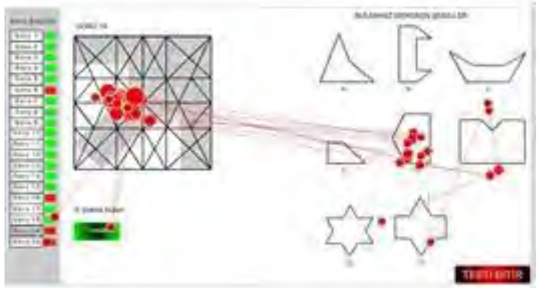
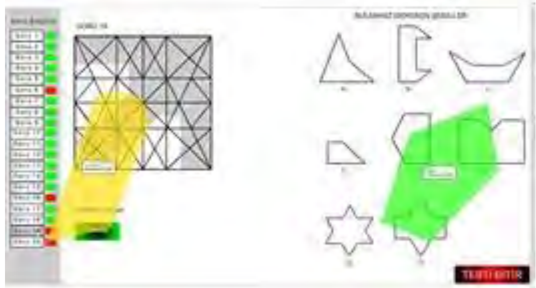
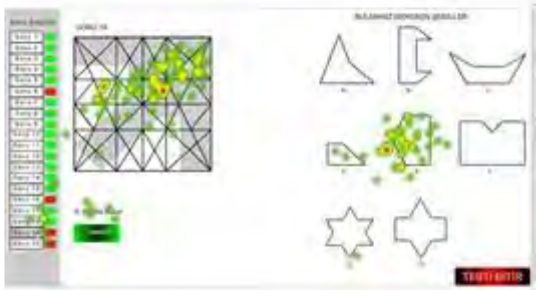
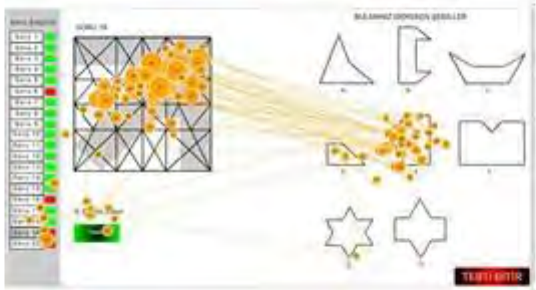
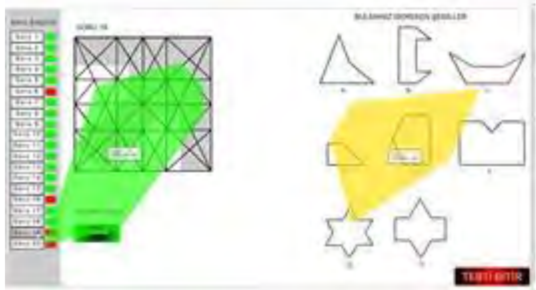
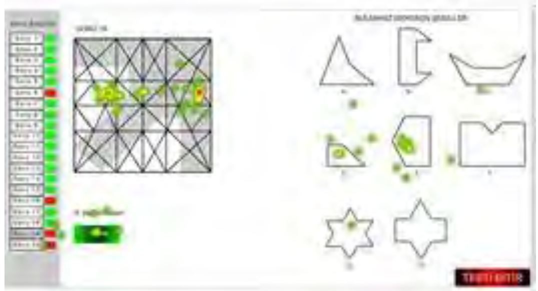
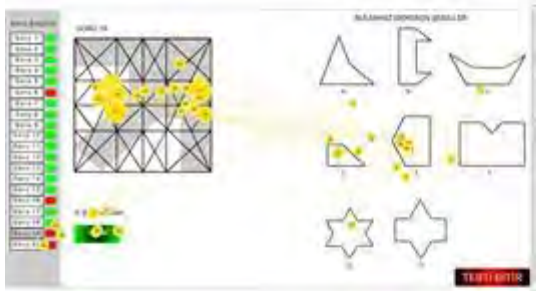
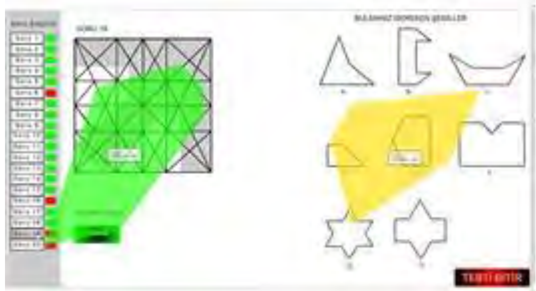
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	-	-----	-----	-----
		Male	1			
	Incorrect answer	Female	2			
		Male	1			

Table 59. Images of Field Independent Preservice Elementary Teachers' Answers to Question 19

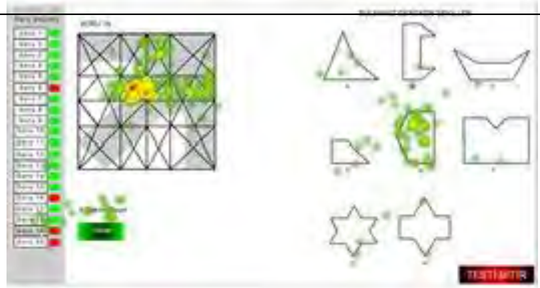
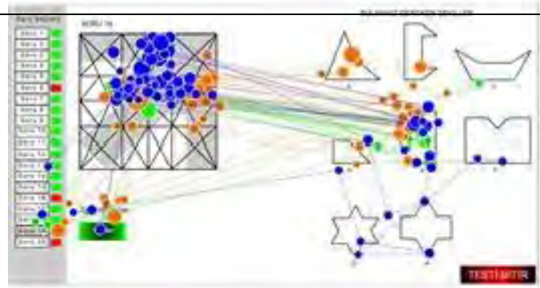
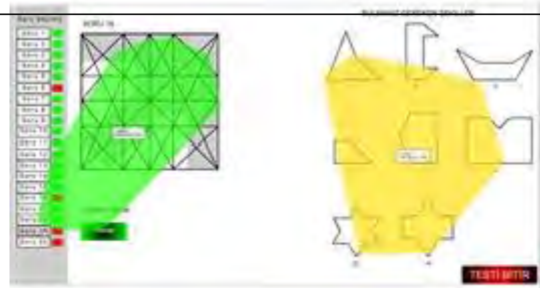
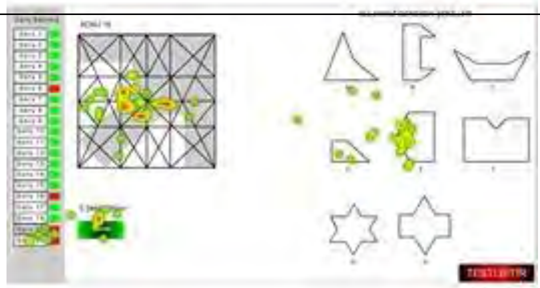
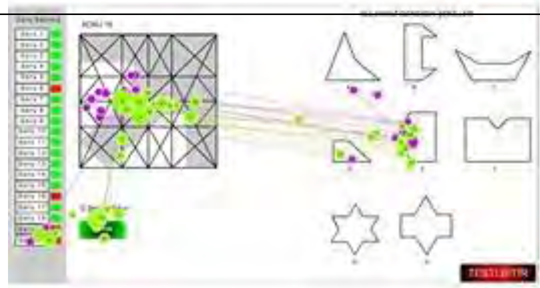
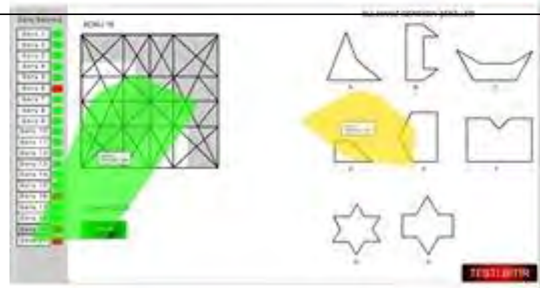
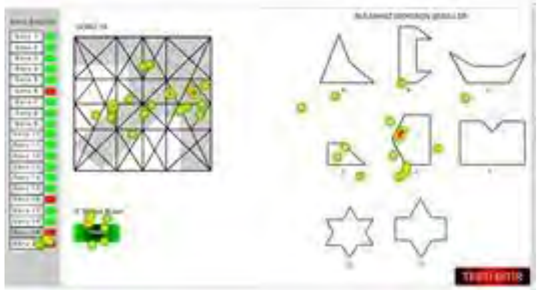
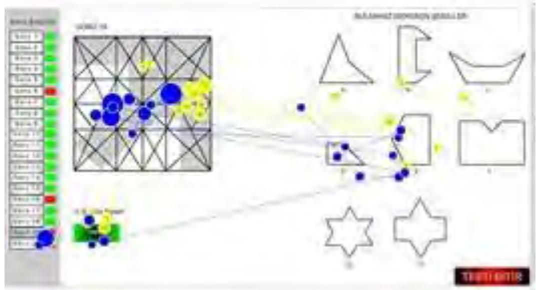
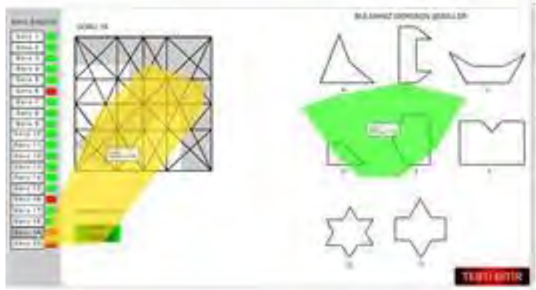
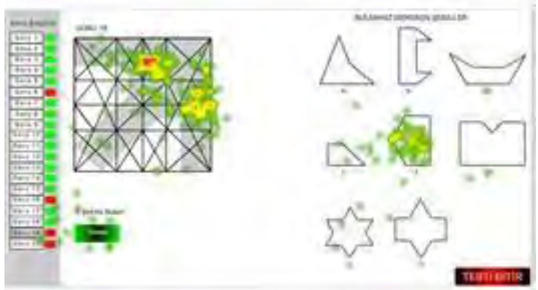
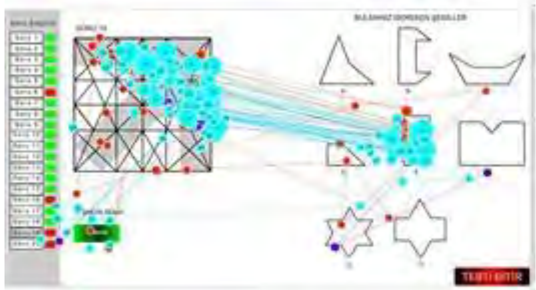
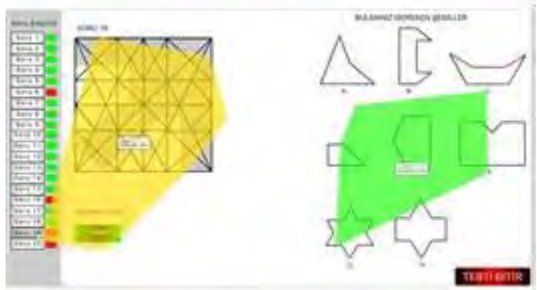
Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	3			
		Male	2			
	Incorrect answer	Female	2			
		Male	3			

Table 60. Images of Field Dependent Preservice Elementary Teachers' Answers to Question 20

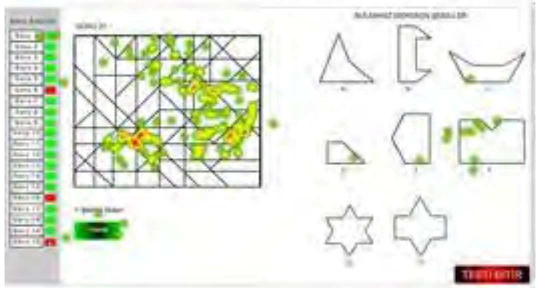
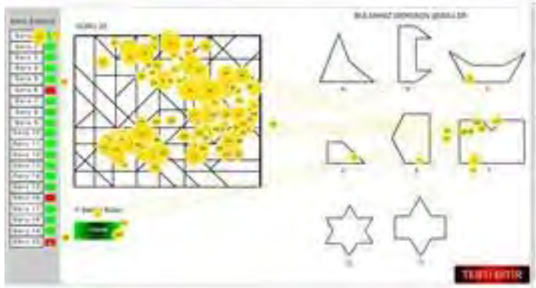
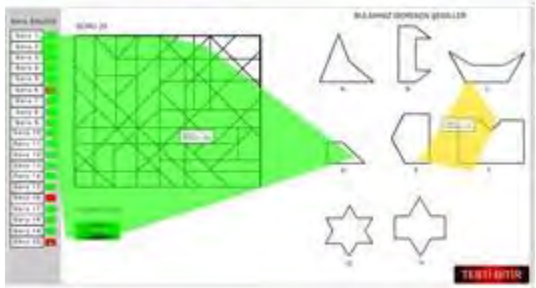
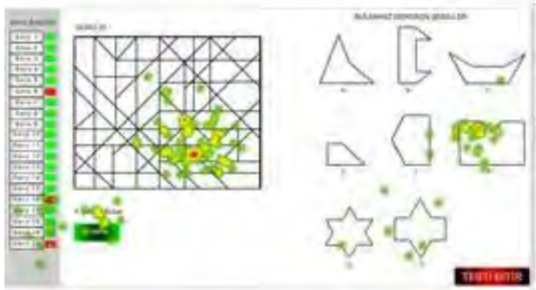
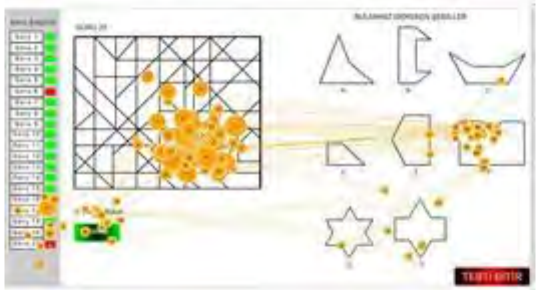
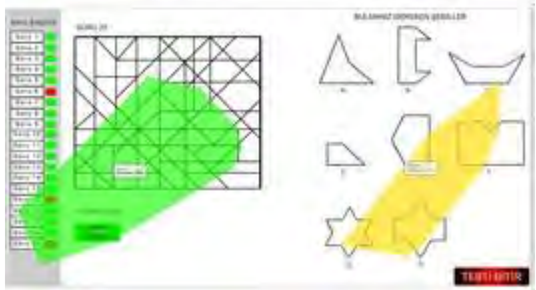
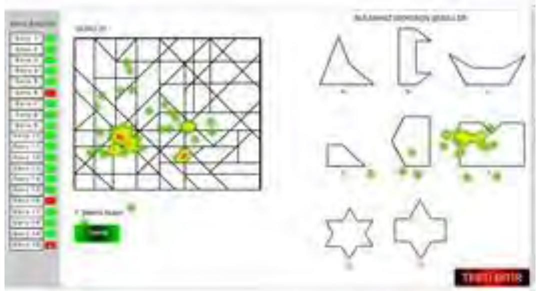
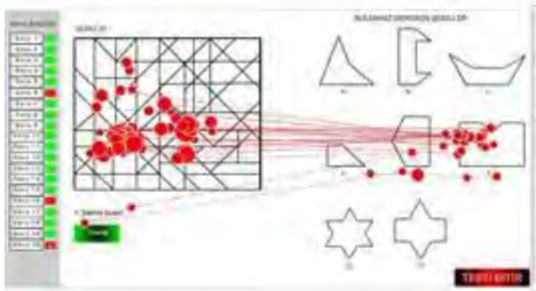
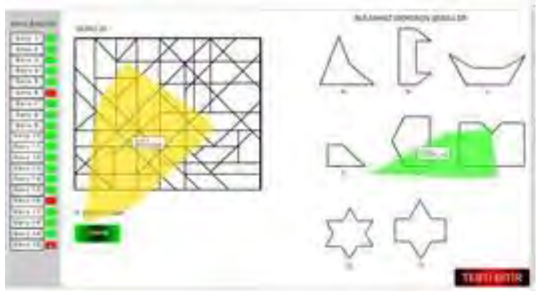
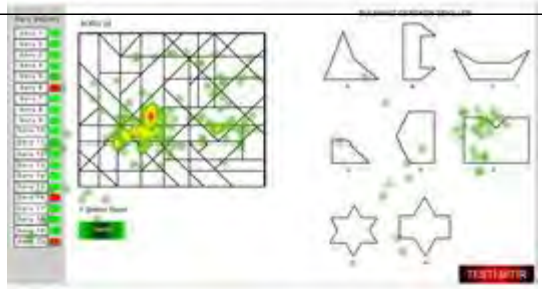
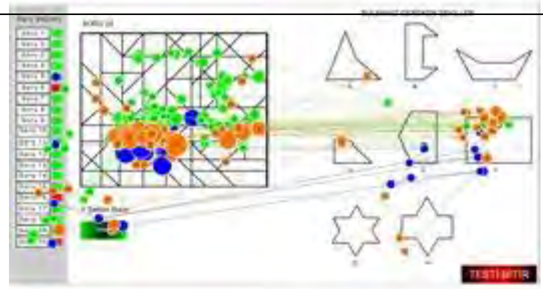
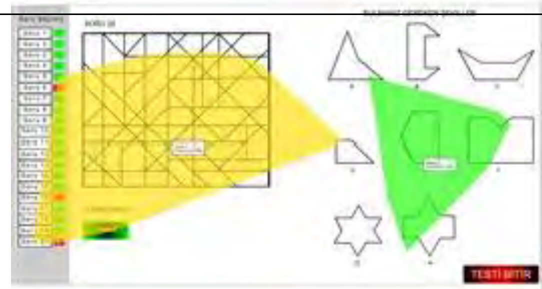
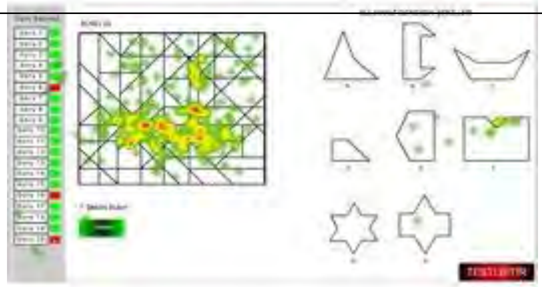
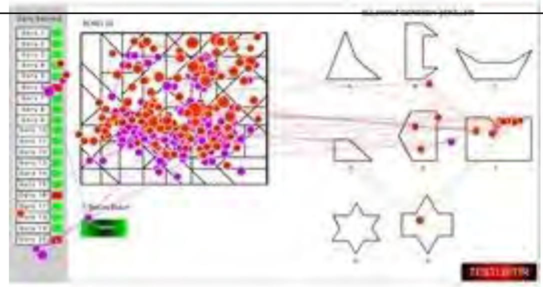
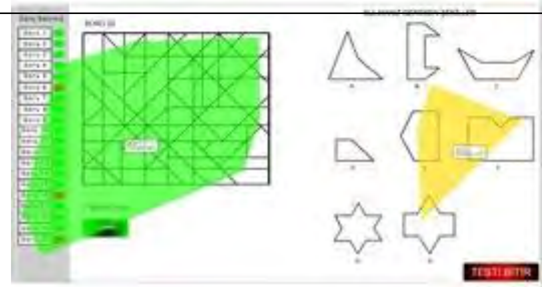
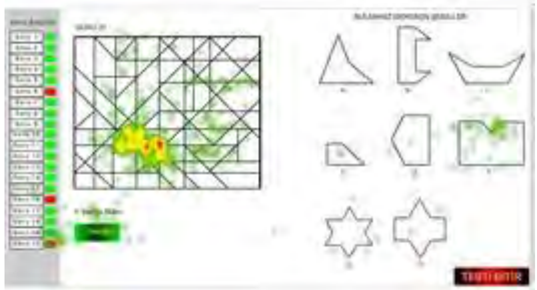
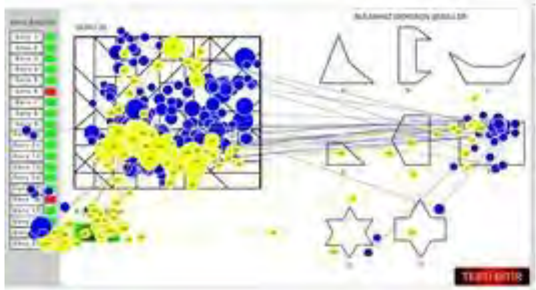
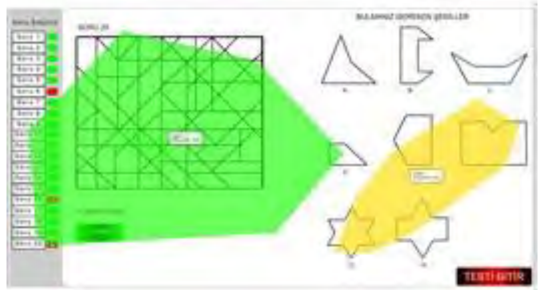
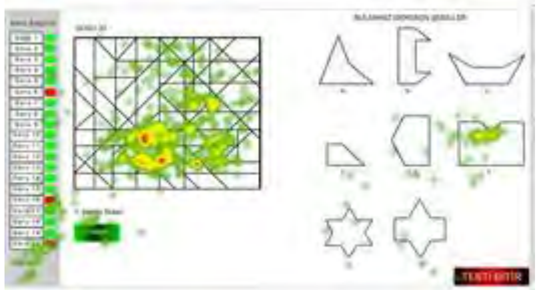
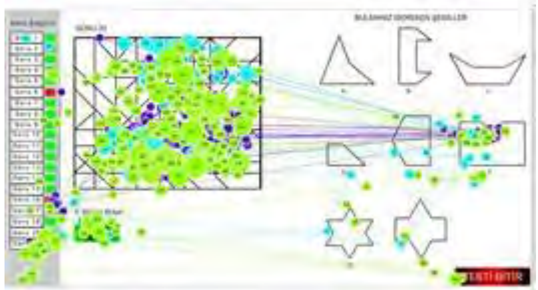
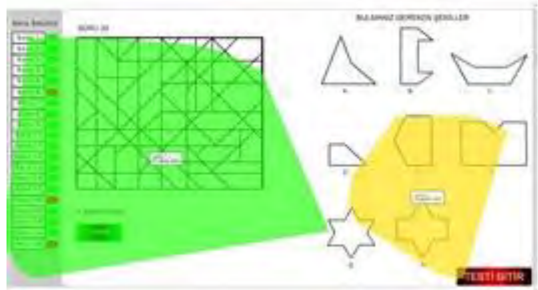
Situation			N	Heatmap	Gaze plot	Cluster
Field Dependent	Correct answer	Female	-	-----	-----	-----
		Male	1			
	Incorrect answer	Female	2			
		Male	1			

Table 61. Images of Field Independent Preservice Elementary Teachers' Answers to Question 20

Situation			N	Heatmap	Gaze plot	Cluster
Field Independent	Correct answer	Female	3			
		Male	2			
	Incorrect answer	Female	2			
		Male	3			

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