The effect of distance education on the problem-solving success of university students taking algebra and students' opinions on the practice[1]

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Abstract

This study aims to examine the effect of distance education in formal education on the success of university students taking algebra in solving algebraic problems and to determine students' opinions on practice. The research design was determined as a posttest quasi-experimental design with a control group. The data collection tools of the research consist of the Algebra Problem Solving Test (APST) consisting of open-ended questions and the Semi-Structured Interview Form (SSIF). SPSS software package version 22.0 was used in the analysis of the data. As a result of the independent samples t-test, it was observed that there was no statistically significant difference between the posttest scores of the experimental and control groups obtained from APST. The qualitative data of the research were analyzed by content analysis. When the opinions of the experimental group students about the practice were examined, it was seen that they stated that distance education had various advantages, but they mostly experienced various difficulties. Students stated the disadvantages of distance education as not being able to ask questions, not feeling like in the classroom, not being motivated to the lesson, not being disciplined due to the comfort of a home environment, internet-related difficulties, inadequate communication, and socialization.

Key words: distance education, algebra, problem-solving success, group theory, university student, opinions on distance education.

1. Introduction

Today, developments in science and technology have led to changes in educational paradigms (Alvarez, Moreno, Orduna, Pascual, & San Vicente, 2015). These changes have differentiated the teaching environments and course materials along with the methods used in education and training. These differences have brought distance education concepts such as e-learning, web 2.0 tools, and online education into the literature (Demir, 2014). According to Karakaya and Aksoy (2005), many reasons such as the constantly increasing number of students in educational institutions, the low number of trained instructors, and the desire of individuals to receive education in different times and places under conditions suitable for their situations have led to the development of different education models. One of the systems developed to solve the problems that arise in education systems is the distance education model. This model is a model in which the teacher and the student do not have to be in the same place and educational activities are carried out through information and communication technologies (İşman, 2011). Since new generation internet technologies are widely used in distance education, it is seen that the concepts of "distance education", "internet-based education", "virtual education", "web-based education", "e-education", "online education" are used interchangeably (Yorgancı, 2014). There is more than one definition of distance education in national and international literature.

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According to Garrison, Anderson, and Archer (2003), the distance education model is a model in which the learner and the teacher can reach each other via the internet and many people can be active in the environment at the same time. According to Moore (1973), distance education is a teaching method in which communication between the teacher and the learner is facilitated by printing, electronic, mechanical, and other tools, and teaching and learning behaviors are made separately (cited in Gökmen, Duman, & Horzum, 2016). According to Uluğ and Kaya (1997), all of the practices developed by teachers and students in different environments regardless of time and place are defined as distance education. The United States Distance Learning Association (USDLA, 2021) defines distance education as the delivery of education and training to distant students with the help of tools such as satellite, video, audio, graphics, computers, and multimedia technology. According to USDLA (2021), electronic tools, printed materials, or equipment should be used in the education program in this system where the teacher and the student are geographically distant from each other. According to Alkan (1987), distance education is defined as a teaching method, when traditional learning and teaching methods are limited and it is not possible to carry out classroom activities, the communication, and interaction among those who plan educational activities, practitioners, and learners are managed from a specific center through specially prepared teaching modules and various environments. Based on all these definitions, the concept of distance education can be defined as an education model in which the educator and the learner are in different places, learning and teaching activities are carried out through information and communication technologies at any time (Aşkar, 2003; İşman, 2011; USDLA, 2021; Uşun, 2006; Verdiun & Clark, 1994).

It is understood that the conditions of the environment in which distance education is applied, the difference of learner needs, and changing conditions cause more than one definition of distance education. This situation has led to the development of different distance education theories. According to Simonson, Schlosser, and Hanson (1999), classical theories suggest that distance education is a different form of education. On the other hand, emerging technology-based theories argue that distance education is not a different field of education. New theories propose both using existing educational theories and creating equivalent experiences that learners can enjoy from all environments. According to Simonson et al. (1999), classical distance education advocates should consider the changes in distance education along with the developing technology. As a result, it is understood that distance education theories and education practices will continue to be discussed today, where technology, society, economy, politics, and learning approaches are constantly changing. What is essential as the basis of all these discussions is to understand the learning needs of learners worldwide and provide the necessary motivation to find effective ways and implement them (Simonson et al., 1999). On the other hand, one of the models developed in distance education is the blended learning model, in which the beneficial aspects of distance education, online education, and traditional education are used together. Picciano (2017) proposes blended learning as an integrated model that combines face-to-face learning with online learning, considered a subset of distance education but is actually a teaching method. In this context, only the theories and models that are thought to be related to the subject of this study are briefly included in this study instead of explaining all distance education theories and models.

2. Literature review

Many researchers interested in distance education (ex. Anderson, 2003; Garrison, Anderson, & Archer, 2000; Moore, 1973, cited in Keegan, 1996; Wedemeyer, n.d.) stated that the theoretical infrastructure of distance education should be established, and they developed various theories about distance education. Based on the existing theories in distance learning, it is seen that the subjects of distance, autonomy, communication and interaction, cooperation, community spirit are researched in each theory. Accordingly, the most studied theories in distance learning in recent years are Moore's transactional distance theory, Garrison,

Anderson, and Archer's (2000) community of inquiry theory, and Garrison's (2003) self-directed learning theory (cited in Gökmen et al., 2016).

Moore states that in the transactional distance theory, the fact that students are physically distant does not mean that they are far from learning, but that distance is due to non-communication and psychological factors that prevent learning (Demir Kaymak & Horzum, 2013). In the theory, which consists of two dimensions: distance and autonomy, the dialogue that provides two-way interaction between the teacher and the student in the distance dimension is taken as the basis, while the autonomy dimension is based on the student's decision-making in the objective, method and evaluation of learning (Moore, 1973, cited in Gökmen et al., 2016).

The community of inquiry theory was developed by Garrison, Anderson, and Archer (2000). This theory is based on studying collaboratively and adopting online learning. The community of inquiry theory is the online learning theory in which students listen to each other with respect, expressing ideas and thoughts and making inferences from different ideas (Lipman, 1991, cited in Garrison et al., 2003). In this theory, there are three dimensions: cognitive presence where students construct their knowledge, social presence where they can share their thoughts and establish relationships with other students by feeling that they belong to the group they are in, and instructional presence that includes the design, facilitation, and management of the process to achieve the desired learning objectives (Garrison et al., 2003).

While Keegan (1996) stated that distance education is complementary to traditional education, he grouped distance education theories under three headings: autonomy and independence theories, industrial theory, and interaction and communication theory. Wedemeyer (1981, cited in Chaney, n. D.) explained the distance education process with four elements: teacher, learner, communication system, that is, content transfer and content. It is important to present these elements in a way that allows more freedom for the learner in the teaching process. Wedemeyer (1981, cited in Chaney, n. d.) listed its features by stating that the basis of distance education is student independence and that this independence should be adopted as a way of application in a technology-based system. Accordingly, the student should be independent of time and place, learning should be independent of the teacher, and the learner should take responsibility for learning. Instructors should devote more time to the development of efficient learning environments with teaching materials, methods, and technologies, and should offer learners such wide opportunities within the system. In this system, individual differences in teaching should be taken into account, each learner should be given learning opportunities, and obstacles such as time, place, and method faced by learners in accessing distance education should be removed and these barriers should be taken into account in the evaluation process. Besides, necessary changes should be made with the evaluation of the process. Moore (1989), on the other hand, mentions the importance of two-way communication between teacher and student in distance education and the level of meeting the student needs of the program. According to Moore (1989), the student should take responsibility for their learning and be determined, and also take an active process with less help from the teacher.

The interaction and communication theory of Holmberg (1997) is based on the interaction between teacher and student at the center of teaching and the active participation of students in the lesson with different opinions, approaches, and solution suggestions of this interaction. Active participation in the lesson and learning environments provides a feeling of belonging to the student, making communication with the teacher comfortable and learning enjoyable. Therefore, the enjoyment of learning and participation in decision-making processes increase student motivation. Thus, high student motivation supports learning by effecting learning positively. However, affective features are neglected in virtual learning environments (Garrison, Anderson, & Archer, 2000). According to Cookson (1989), since distance education studies are mostly concerned with system infrastructure, studies on the psychological and social conditions of learners in distance education are not done at a sufficient level.

The components of synchronous and asynchronous distance education are learning management systems, e-content, virtual classroom, and assessment-evaluation (Demir, 2014; Nichols, 2003). According to Demir (2014), although each of these components has its characteristics, there is a spiral structure among them, and success in distance education can only be achieved by constructing this spiral structure well. The learning environment in distance education is provided by the Learning Management System (LMS), which is a system that provides management of the educational environment over a network connection created using specific software and consists of certain components for learning and teaching (Nichols, 2003). This system is a distance education software in which lessons are conducted synchronously or asynchronously over a network and provides learners with many opportunities such as adding, editing, and sharing learning materials such as animation, video, presentation in the learning environment, creating interactive virtual classes, discussing and assigning homework (Nichols, 2003). Synchronous education is defined as a virtual classroom system in which the learner and the educator are together with various methods (Işık, Karacı, Özkaraca, & Biroğul, 2010). In synchronous interaction, a simultaneous education environment can be created with the communication provided by the transmission of the images and sounds of the parties via the internet, and the student can feel in a virtual classroom (Işık et al, 2010). The advantage of synchronous education environments can be considered as the ability to transfer the discussion atmosphere of traditional classroom environments to the educational environment. However, in such educational environments, the parties must have sufficient technical equipment and the competence to use technology together with appropriate technological infrastructure (Özkaraca, 2005). Asynchronous education can be considered as an education platform prepared in such a way that the student can start and end education whenever they want, independent of the teacher (Işık et al, 2010). On this platform, the course content is prepared in advance and delivered to the students via the internet. The most important disadvantage of this education is the delayed interaction and communication between the parties (Yorgancı, 2014). Conducting synchronous and asynchronous interaction together and complementary to each other creates more efficient learning environments (Duran, Önal, & Kurtuluş, 2006; Yorgancı, 2014).

Studies on distance education have shown that distance education has some advantages and disadvantages (Dumford & Miller, 2018; Gossenheimer, Bem, Carneiro, & de Castro, 2017; Naidu, 2019; Santana de Oliveira, Torres Penedo, & Pereira, 2018). Some of these advantages are as follows. It supports autonomy and self-learning, is flexible in time and place, less expensive than traditional education. Also, it attracts the attention of learners more than traditional teaching methods. It provides suitable learning environments for learners with special needs in education. Disadvantages in distance education are listed as follows. There are various distractions due to the incomplete control of the teacher over the teaching situations. The lack of technical skills of teachers and learners reduces the quality of distance education. Distance education creates a lack of social interaction and communication between teacher-student and student-student. When distance education is not well planned, it is likely to provide an education that is not better than traditional education. Difficulties are experienced in students' discipline and organization and the individual approach towards students (such as academic counseling) decreases. Since it has various limitations in applied courses (such as medicine, areas of expertise that need to be experimented), it is difficult to apply and is mostly limited to learning foreign language lessons.

Salomon (1998) points out that the integration of technology into educational environments and the creation of new learning environments where student participation is ensured are important in increasing the quality of education. According to Salomon (1998), ensuring the diversity of technology to be used in education and training, access to information and intensive use of technology are among the important features of such learning environments. The results of the study conducted by Stuiah, Slamet, Shafqat, and Supriyona (2020) with a questionnaire on 750 students showed that students preferred to learn face-to-face instead of distance education. The same researchers emphasized that students face many difficulties in distance education and it is also important to acknowledge that distance learning cannot replace the need for face-to-face learning, but that distance learning can complement existing traditional classroom-based learning models.

Koç (2020) states that students have a positive attitude towards learning with distance education and that they consider the control of the education environment and study process by the student as positive aspects. The students stated the negative aspects of learning by distance education as the inability to receive feedback from the instructor of the course, insufficient communication and interaction, and the inability to follow the courses regularly by the students due to low motivation. Akgün, Güleç, and Topal (2013) state that graduate distance education students have positive opinions on distance education, but they see technical infrastructure problems as an important problem. On the other hand, NCTM (2000) states that it is important to implement new strategies that will facilitate the conceptual understanding of students in mathematics education and integrate technology into the classroom and teaching. Especially, NCTM's (2000) proposal to use such new strategies in line with the principles and standards set for school mathematics has made the use of information communication technologies in mathematics teaching quite widespread. However, with the emergence of distance education technology, it has become a matter of debate whether the expected gains in mathematics teaching can be achieved. Questions began to be asked about how teachers would carry out group and cooperative learning activities in distance education, how they would encourage the use of technology for mathematics teaching, and how they would use technology (Krussel, n. d.). According to Sakshaug (2000), mathematics educators need to create learning environments between themselves and their students in distance education environments where the student is engaged in their own learning experiences and feels a part of the learning experience. For this reason, it is important for mathematics educators to receive training on the most effective use of distance education technology (Sakshaug, 2000).

Distance education, in which interaction and communication between teacher and student are limited and time and place are flexible, basically turns it into an attempt to artificially present learning (Sugilar, 2019). Sugilar (2019) stated that distance education in mathematics teaching reveals many problems in his study on four different groups, where learning support services are provided to students who want and where they are given face-to-face or online education by using independent learning materials in distance education. The students determined the groups they were included in according to their wishes and conditions. Printed learning modules have been arranged in which students can study independently. The modules have been prepared in a way that enables students to acquire the competencies that they can gain with the help of an instructor in face-to-face education through distance education (Sugilar, 2019). With the practice carried out in the continuation of the study, the educations in which the students were given the opportunity to participate in none, any, one or both of the face-to-face and online practices were carried out, and an assessment exam was applied in accordance with the objectives of the curriculum to evaluate the learning. As a result of the study, it was found that the average success of the group who participated in both face-to-face and online educations together was higher than the average of the other groups. Secondly, the highest average of success belongs to the group that did not participate in any face-to-face and online educations. This group consists of students who adopt independent learning, understand course materials, and do not access any learning support services by studying through printed modules. In addition, it was observed in the study that the average success rate of the group that only participated in online education was higher than the average of the group that only participated in face-to-face education (Sugilar, 2019). In the study by Moreno-Guerrero, Aznar-Díaz, Cáceres-Reche, and Alonso-García (2020), it was stated that, on secondary school students, the e-learning method was effective in motivation, autonomy, and participation, in learning mathematical subjects, in raising the final grade, and that e-learning is more applicable than traditional methods. The researchers stated that the emergence of these results may have resulted from the student's taking responsibility for learning himself.

In higher education institutions where distance education practices are widespread, it is seen that discipline areas such as mathematics are also offered with distance education (DePriter, 2013). DePriter (2013) stated that it is inevitable to experience various difficulties in distance education, but the important thing in this process is to determine how educators can benefit from distance education practices to provide students with effective and meaningful teaching experiences. DePriter (2013) compared

the distance education practice with traditional practices in his experimental study in which he investigated whether distance education practices are effective in mathematics lessons, but there was no statistically significant difference in the study.

It is known that some difficulties inherent in mathematics affect learning and teaching mathematics. This situation emerges as a bigger problem in online mathematics lessons. Because students who take mathematics lessons among online courses feel more anxious and fearful (Bird & Morgan, 2003; Conrad, 2002; Hembree, 1990; Mensch, 2010). According to Mayes (2011), this problem stems from the difficulty in conveying mathematical ideas to students with symbols and graphics in online lessons. Engelbrecht and Harding (2004) stated that technology itself is a hindering factor in the distance education of mathematics. The reasons for the ineffectiveness of distance education in mathematics teaching are that mathematics has a conceptual structure and that educators think that they can only transfer these concepts to students in face-to-face classroom environments and that today's internet technology offers limited opportunities in displaying mathematical symbols (Engelbrecht & Harding, 2004). However, according to DePriter (2013), some studies (Chinnappan, 2006; Evans et al., 2008; Williamson, 2006) suggest that a distance education model is based on a constructivist basis can overcome these difficulties. Chinnappan (2006) used discussion and collaborative teaching methods in the process of creating knowledge in online mathematics lessons with grown-up students. Yorgancı (2014) states that the web-based distance education method significantly affects students' mathematics achievement compared to the traditional method and that the web-based learning environment is an effective method in terms of rich content, flexibility, suitability for individual learning, and time-saving. In addition, in this study conducted with university students (Yorgancı, 2014), it was stated that the vast majority of students thought that interaction could not be achieved in the web environment as in the traditional classroom environment. Summerlin (2003) examined the effect of internet-based mathematics teaching on students' academic achievement. In the study, it was observed that the vast majority of the students in the control group where the traditional face-to-face education method was applied completed the course, but the majority of the students in the experimental group in which the internet-based teaching method was applied dropped out and the failure rate in this group was very high. According to Yorgancı (2014), studies have revealed that the conceptual, symbolic, and abstract structure of mathematics is an obstacle in the application of web-based teaching methods in teaching mathematical subjects. On the other hand, there are also studies (Şendağ & Odabaşı, 2009; Ponte & Santos, 2005; Lin, 2009) that aim to obtain richer learning outcomes with the methods used in web-based mathematics teaching (Yorgancı, 2014).

According to Argün, Arıkan, Bulut, and Halıcıoğlu (2014), algebra, which is an important branch of mathematics, is based on the principle of finding the unknown values with the equations established by symbolizing them with signs and letters or determining the relations between the unknowns. Algebra, which is a science of abstraction (Altun, 2015), is a branch of mathematics that examines the features and relationships of numbers in the most general way (Usiskin, 1987) and transforms these relationships into generalized equations. Algebra is an important branch of mathematics dealing with the structure, relation, and quantity.

According to Asar, Arıkan, and Arıkan (2012), algebra lessons are suitable environments for students to develop their ability to make valid reasoning and draw correct conclusions. Because the adequate application of the proof techniques learned in algebra lessons to the problems improves the students' reasoning and inference skills. However, research shows that abstract algebra is perceived as difficult by students because it is based on abstraction and proof (Capaldi, 2014; Grassl & Mingus, 2007; Leron & Dubinsky, 1995). To overcome these perceived difficulties, researchers have been recommending student-centered learning methods in recent years (Hoffman, 2017).

The subjects of abstract algebra have emerged as a result of Galois solving the problem of finding a formula for the roots of the polynomial by applying four operations and square roots to the coefficients of a degree polynomial, which is the basic problem of classical algebra. The solution to this problem has been the harbinger of new developments in the field of algebra. Until then, studies that were limited to equation solutions, after the solution of Galois, algebraic systems based on abstract axioms were

started to be studied and as a result, the concepts of group, ring, and field emerged (Asar et al, 2012). In this study, group theory problems, one of the main topics of abstract algebra, are included.

As the problem of the study, "Does distance education have a significant effect on the problem-solving success of university students taking algebra and what are the students' opinions on the practice?" was determined. Also, the concept of distance education was used in this study to mean that distance learners and teachers can reach each other through the "Learning Management System" and that more than one person can be in the same environment at the same time (Garrison, Anderson & Archer, 2003). In this research, distance education and algebra lessons were conducted synchronously and asynchronously. The difference of this study from the researches on distance education and mathematics teaching in the literature is thought to be the distance education research on the success of university students in solving algebra problems based on group theory, which is the basis of abstract algebra lessons. In this context, it is hoped that this research will contribute to the literature.

2.1. The aim of the research

This study aims to examine whether there is a significant difference between the success of university students in solving algebra problems in distance education and their success in algebra lessons given face-to-face education. In addition, in this study, the opinions of university students about the distance education process within the scope of algebra courses were also examined. In this direction, the sub-problems of the research are given below and answers were sought for these sub-problems.

The sub-problems of the research

2.1.1. Is there a statistically significant difference between the success of university students taught by distance education in solving algebra problems and the success of university students in the class taught with face-to-face education in solving algebra problems?

2.1.2. What are the opinions of university students about the distance education process in algebra courses?

3. Methodology

In this study, quantitative and qualitative research approaches were used together to obtain comprehensive and detailed results. The analysis of qualitative data offers a supportive approach in determining how the results of the analysis of quantitative data change in the process. The reason for this is that it is not possible to analyze in depth how students make sense of concepts and how they think with the analysis of quantitative data. The use of both researches approaches together makes it possible to eliminate the weakness of a single method, to provide ease of explanation by using numerical and verbal values together, and to reveal strong evidence supported by different methods as a result of the research. In this context, the support and approval of the two methods allow for a detailed and advanced analysis, and the synthesis between the two methods and the elimination of the deficiencies of the methods provide an opportunity for the reliability of the research (Giannakaki, 2005, cited in Butgel-Tunalı, Gözü, & Özen, 2016, Rossman & Wilson, 1994). Therefore, in this study, it was deemed necessary to obtain qualitative data by taking the opinions of university students about the practice process.

In this research, quantitative and qualitative methods were used together to enrich the research, make more detailed explanations about the research, and evaluate the practice result as well as the practice process. The method of the research, data collection tools, and data analysis are presented in Figure 1. Afterward, the method of the research is explained in detail under the headings.

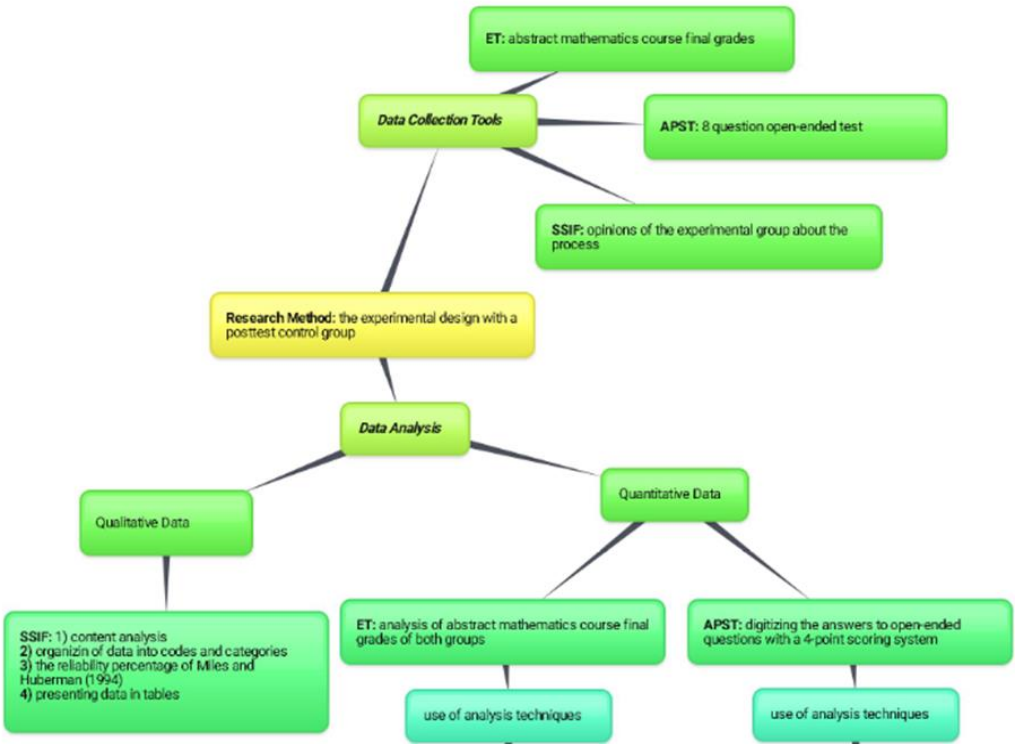

Figure 1. Research Method

3.1. Research Model

The model of the research is the experimental design with a posttest control group, which is one of the true experimental designs. At the end of the practice, only the final test is applied to both groups (Karasar, 2005). The experimental design of the research can be seen in Table 1. (Experimental Group: DG, Control Group: KG).

Table 1. Experimental Design of the Research

Group	Equivalence Test	Practice	Posttest
	Abstract Mathematics Lecture Notes		Algebra Problem Solving Test (APST)
EG	O_1	Lecture with Distance Education	O_3
CG	O_2	Face-to-Face Lecture	O_4

Table 1 shows the final grades obtained from the abstract mathematics course evaluation reports of the O_1 experimental group, and O_2 control group. These notes are used to show that both groups are equivalent before starting the practice. O_3 shows the posttest measurements applied to determine the effect of distance education algebra lessons to the experimental group on the students' success in solving algebra problems, and O_4 shows the posttest measurements taken from the end-of-term course evaluation reports of the algebra lesson applied to the control group through face-to-face lectures. In the study, qualitative data were obtained by examining the opinions of university students about the distance education process. Qualitative data were analyzed by content analysis.

3.2. Research Group

The research group of this study consists of a total of 90 university students, 50 in the experimental group and 40 in the control group, who are studying in the 3rd year of the primary school mathematics teaching department of a university in the Western Black Sea Region. In order not to affect the results of the research, the abstract mathematics course and algebra course of both groups were conducted by the same instructor. Abstract Mathematics lesson was conducted with face-to-face direct lecturing method in both groups. The final grades of the abstract mathematics course were used as an equivalence test (ET) to show the equivalence of both groups. The questions in the APST applied to the experimental and control groups were applied to the control group in the final exam at the end of the 2019-2020 fall semester. APST was applied to the experimental group through the "Instructional Management Information System" at the end of the distance education practice in the 2020-2021 fall semester. In Table 2, the periods to which the tests applied to the experimental and control groups belong are given.

Table 2. The Periods to Which the Tests Applied to the Experimental and Control Groups Belong

Groups	Abstract Mathematics Course Final Grades	Test for Solving Algebra Problems
CG	2017-2018 Spring Semester	2019-2020 Fall Semester
EG	2018-2019 Spring Semester	2020-2021 Fall Semester

3.3. Data Collection Tools and Data Analysis

Abstract mathematics course final grades, algebra problem-solving test, and semi-structured interview form were used as data collection tools in the research. Before starting the practice, the final grades of the abstract mathematics course were used as the "Equivalence Test (ET)" to show the equivalence of the experimental and control groups. "Algebra problem-solving test (APST)" was prepared as an open-ended test consisting of 8 questions to be applied to the experimental and control groups as a posttest.

The questions in the APST were prepared within the scope of the algebra lesson outcomes in the Primary Education Mathematics Undergraduate Program (2018). Accordingly, the outcomes of the algebra lesson are given in items.

- States the binary operations and explains the features it provides when an operation is given.
- States the concept of group and explain whether an algebraic structure is a group.
- Defines subgroup and subgroup theorems and applies them to problems.
- States the concept of cyclic (sub) group and explain whether a given group is cyclic or not. States basic theorems about the cyclic group and applies to problems.
- Explains the definition of the order of an element and solves problems related to order.
- Defines group homomorphisms, explains their properties and makes applications.

The questions in the APST prepared as open-ended and cited from the literature (Asar, Arıkan, & Arıkan, 2012) are given in Table 3.

Table 3. Questions in the APST

1) Is there an injective $f: \mathbb{R} \to \mathbb{R}^+$ function, although it is a surjective function? Explain your answer.

2) Are the algebraic system $G = \mathbb{Q}$ and $a * b = \frac{ab}{2}$ $(G,*)$ a group? Explain your answer.

3) Determine the orders of the elements of the group $(\mathbb{Z}_{12}, +)$.

4) "Let G be a group. Let $\{H_i: i \epsilon I\}$ be a family of subgroups of G. In this case, $D = \cap_{i \epsilon I} H_i$ is a subgroup of G." Show the correctness of the proposition. Explain your answer.

5) Identify all generators of the $(\mathbb{Z}_{12}, +)$ group. Explain your answer.

6) Identify the $< \overline{18} >$ subgroup of the cyclic group $\mathbb{Z}_{45}$. Explain your answer.

7) Let " $\varphi: G \to H$ be a group homomorphism. For φ to be a monomorphism, if and only if $Ker\ (\varphi) = \{e_G\}$ olmasıdır." Prove the theorem.

8) Group G and a subgroup H of G are given. Identify the left cosets of H and $|G: H|$ index. $G = \mathbb{Z}_{56}$ is given as $H = < \overline{16} >$.

For the concepts and definitions that form the basis for solving problems within the scope of group theory, see the publication Asar, Arıkan, and Arıkan (2012) given in the references.

The second qualitative data collection tool is the "Semi-Structured Interview Form (SSIF)" prepared by the researchers, in which the opinions of the experimental group students about the distance education process were determined (See App.1). The form was sent to the students via the "Educational Management Information System". Students were asked to give their answers with a written explanation and the answers were received via e-mail. Afterward, online interviews were held with 5 students through the "Learning Management System".

The strategies used to ensure the validity and reliability of qualitative research differ from quantitative research. Accordingly, the concept of credibility is used instead of internal validity, transferability instead of external validity or generalization, consistency instead of internal reliability, and confirmability instead of external reliability or repeatability (Yıldırım & Şimşek, 2008). Long-term interaction, deep focused data collection, diversification, expert review, and participant confirmation strategies are used to ensure credibility (Lincoln & Guba, 1985, cited in Yıldırım & Şimşek, 2008). One of the researchers who conducted this study has been conducting the lessons with students for a long time and had a long-term interaction with them, which reduced the effect that might arise from the researcher's existence and subjective perceptions. The researcher effect decreases with creating an environment of trust arising from long-term interaction between the researcher and the students. For this reason, it can be said that both students' answers given to the semi-structured interview form and the answers given during the five online one-to-one interviews were sincere. The validity of the data collected through long-lasting interviews is higher (Yıldırım & Şimşek, 2008). Using the data collected through the semi-structured interview form to confirm each other will increase the validity and reliability of the results. For this reason, one-to-one online interviews were conducted with five students participating in the research, and they were asked to detail their answers in the interview form. Another measure used to increase the validity and reliability of this study is to apply the semi-structured interview form created by two researchers who are experts in the field to 4 fourth-grade teacher candidates/students studying in the same department in order to determine whether it is suitable in terms of purpose, content, and comprehensibility; and make corrections in the interview form in line with their opinions. Afterward, the semi-structured interview form took its final shape and applied to the students of the experimental group. Besides, the codes and categories that emerged by organizing the raw data were conveyed without adding any comments and by sticking to the nature of the data as much as possible. This situation is seen in the codes and categories created in the findings section. The purpose of this is to present data to the reader meaningfully in a particular order and allow the reader to compare the results of the study

obtained by establishing the relationships between the data and the interpretations that the reader will create themselves (Yıldırım & Şimşek, 2008).

The studies carried out to increase the validity and reliability of this research are explained in more detail in the following paragraphs. In this study, the semi-structured interview form given in Appendix 1 was prepared to examine the opinions of the experimental group students about the algebra course given through distance education. Two experts prepared the questions by reviewing the literature in line with the purpose of the study, taking into account criteria such as purpose, content, and response time. Due to the pandemic, the questions were asked online to 4 mathematics teacher candidates/students from fourth grade to measure the clarity. It has been observed that the question, "Are there any features that you think are definitely necessary to be developed in distance education for this course? Explain your answer." is not fully understood. The form was given its final shape by replacing this question with more detailed and descriptive questions, "Write your positive thoughts about this course given through distance education.", "Write your criticism for this course given through distance education." At the end of the application, students were asked to answer the questions in writing and explain their answers in detail. Online interviews were conducted with five students to confirm the compatibility of the draft codes and categories created from the data obtained from the written explanations and to understand the students' answers better. These interviews were recorded in order to prevent data loss. The students' answers to the questions were not clear and understandable enough; therefore, researchers decided to conduct one-on-one interviews. In this way, the validity of the draft codes and categories was evaluated. These interviews lasted approximately 25-30 minutes for each. After examining the answers of 5 students, the draft codes and categories were rearranged and finalized. In line with the reliability of the study, the answers of each student were examined by two researchers who are experts in the field and coded independently according to the codes they created. The agreement ratio was found to be 91%, according to the formula of Miles and Huberman (1994). Two researchers came together and discussed the remaining differences, and a complete agreement (100%) was achieved by increasing inter-coder consistency. The data obtained from the answers of students were grouped according to the determined codes and categories; their frequencies were given and presented in the findings section in tables. Information about the data analysis is explained in detail in the following paragraphs.

First of all, the analysis of whether there is a statistically significant difference between the APST posttest scores of the experimental group in which distance education was applied and the control group in which face-to-face direct lecturing method was applied and carried out using the SPSS 22.0 package program with quantitative data analysis techniques. An answer key was prepared for the APST, which consists of open-ended questions, and the answers of the students to the questions in the test were evaluated by two researchers with a 4-point scoring system. These were determined as correct (4 points), partially correct (a) (3 points), partially correct (b) (2 points), incorrect (1 point), and unanswered (0 points). The meaning of the scoring is as follows:

Correct: The condition of showing all the scientific ideas on which the answers of the questions are based, and the complete solution,

Partially correct (a): Showing the scientific ideas on which the answers of the questions are based and the solution being made with minor mistakes,

Partially correct (b): The condition that the scientific ideas on which the answers of the questions are based are not sufficiently and fully showed and the solution is almost incorrect,

Incorrect: The lack of scientific opinions on which the answers of the questions are based or the incorrect expression and the condition of giving answers that are not related to the answer of the question,

Unanswered: The condition that the questions have not been solved or left blank.

Secondly, content analysis, one of the qualitative data analysis techniques, was used in the analysis of qualitative data. Content analysis is the summary of parts of a text in smaller and fewer words within the framework of a certain system and rules (Büyüköztürk, Kılıç Çakmak, Akgün, Karadeniz, & Demirel, 2013). The data obtained in the content analysis are organized according to previously determined categories and codes (Yıldırım & Şimşek, 2018). The purpose of content analysis is to reach the concepts and relationships that explain the data collected. The data are conceptualized, organized logically and the themes explaining the data are determined (Yıldırım & Şimşek, 2018). In this study, content analysis was carried out by using the categories and codes created by the researchers with the data obtained by SSIF. In line with the reliability of the study, the data were coded independently by two researchers, who are experts in the field, according to the categories and codes created by the researchers. Then, the reliability percentage of the generated coding was calculated according to the formula of Miles and Huberman (1994).

Reliability Percentage = Total Agreement / (Total Agreement + Disagreement) x 100

According to Miles and Huberman, the reliability percentage being at least 70% shows that the reliability is achieved. The data obtained from this study were organized into codes and categories by the researchers, and since the coding percentage was reached at a consensus of 91%, reliability was obtained in terms of data analysis. In addition, as a result of different coding, the coders came together and discussed, and as a result, a full consistency (100%) was achieved by increasing the consistency between the coders.

3.4. Practice Process

In this section, the practices made to the experimental and control groups during the research are explained. Accordingly, in line with the outcomes determined within the scope of the algebra course in the 2019-2020 fall semester, the control group was taught through face-to-face lectures for 12 weeks, 3 hours a week, in the classroom environment. During the lectures, attention was paid to the participation of the students, and the unclear parts were repeated by giving the opportunity to ask questions. At the end of the semester, APST was applied and the results were transferred to the course evaluation reports as the final grade.

Algebra course was given to the experimental group over the system determined by the university to be used in distance education with synchronous and asynchronous practices. In the experimental group, in the 2020-2021 fall semester, distance education continued for 12 weeks, 3 hours a week in line with the outcomes determined in the undergraduate program. Lectures were made live over the link sent to the students via the "Learning Management System" and the students' questions were answered during the lecture. Also, the students were given the opportunity to ask questions and discuss opportunities in the live lectures. To solve the homework questions given to the students and to ensure classroom interaction, additional live lectures were held at the request of the students. Live lectures were recorded and shared with the link sent to the students on the system. Thus, students who could not attend the live lectures or want to listen to the lecture again carried out their studies via the link provided. Documents, asynchronous videos, and various files prepared about the content of the course before the live lectures were shared with the students via links. In this way, students had the opportunity to survey and study subjects before attending live lectures. After each lecture, the students were given various assignments and they were asked to submit them within the specified time. Homeworks were examined by the instructor of the course and feedback was given to the students. Thus, the subjects or details that the students did not understand were repeated with different examples and the subjects or details were understood. Homework made it easier for students to understand the basic definitions and theorems within the scope of the algebra lesson and confirm their application to problems. At the end of the lectures, APST was applied to the experimental group and the results were transferred to the course evaluation reports as the final grade. Figure 2 shows the experimental practice process.

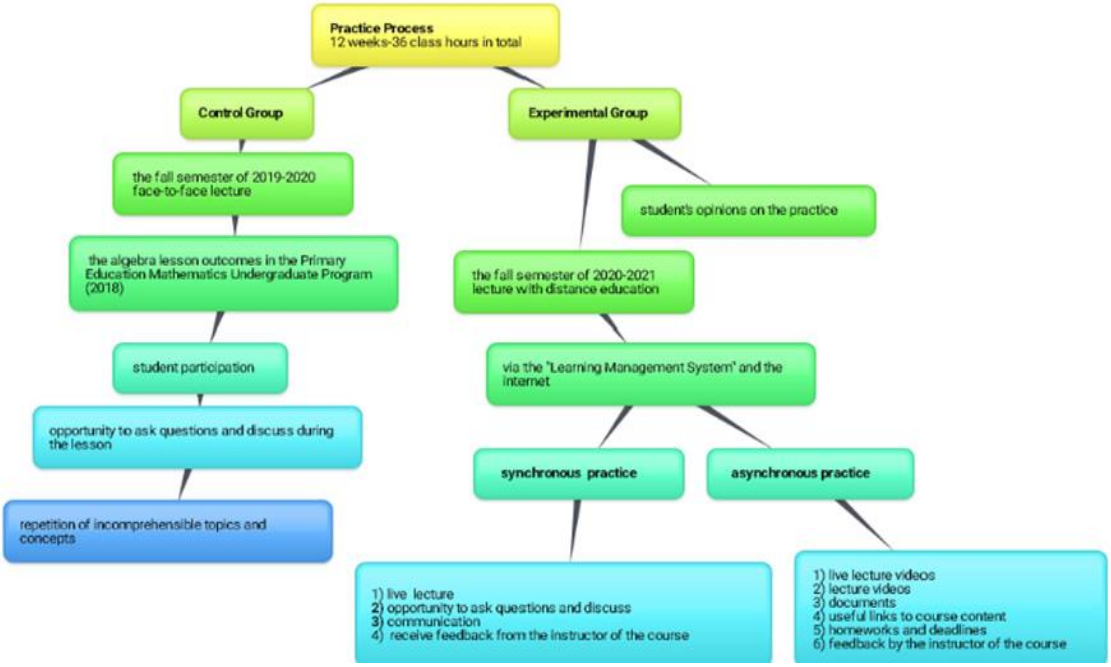

Figure 2. The Experimental Practice Process

4. Findings and Interpretation

In this part of the research, findings and comments obtained from the data throughout the research are included. First, the results of the ET conducted to determine whether the two groups are equal or not are included. Later, the sub-problems of the research were compiled in sections.

4.1. ET Results

The normality test performed to compare the equivalence of the experimental and control groups is given in Table 4.

Table 4. Normality Results of ET Scores of Experimental and Control Groups

	Kolmogorov-Smirnov			Shapiro-Wilk			Skewness	Kurtosis
	Statistic	df	Sig.	Statistic	df	Sig.		
G	.113	50	.125	.912	50	.001	-1.086	.982
G	.101	40	.200	.979	40	.641	-.084	.081

It is understood from Table 4 that the scores of the experimental and control groups in the ET show normal distribution (p_{EG}=.125, p_{CG}=.641). In this case, t-test results for independent samples are given in Table 5.

Table 5. T-Test Result of ET Scores of Experimental and Control Groups

Groups	N	$\bar{X}$	Ss	t	p
EG	50	65.78	16.623	1. 742	.085
CG	40	59.21	18.639		

As seen in Table 5, p = .085 was calculated as independent samples t-test result of ET scores of the experimental and control groups. Since the calculated p-value is greater than .05, there was no statistically significant difference between the experimental and control groups before the practice. [t(88)=1.742, p=.085 >.05]. In this case, it can be said that the experimental and control groups were equivalent to each other before the practice of distance education.

4.2. Findings and interpretation of the first sub-problem

The normality test of the APST posttest data of the experimental and control groups is given in Table 6.

Table 6. Normality Results of APST Scores of Experimental and Control Groups

	Kolmogorov-Smirnov			Shapiro-Wilk			Skewness	Kurtosis
	Statistic	f	Sig.	Statistic	f	Sig.		
G	.113	0	.095	.959	0	.080	-.533	1.032
G	.092	0	.200	.988	0	.937	-.084	.081

Table 6 shows that the posttest scores of the experimental and control groups from the APST show a normal distribution (p_{EG}=.095, p_{CG}=.937). In this case, the results of the independent samples t-test were performed to compare the posttest scores of the experimental and control groups from APST, and the finding of whether there is a significant difference is given in Table 7.

Table 7. T-Test Result of APST Scores of Experimental and Control Groups

Groups	N	$\bar{X}$	Ss	t	p
EG	50	56.14	17.170	.587	.559
CG	40	58.02	13.294		

Table 7 shows the results of the independent samples t-test made among the posttest scores of the experimental and control groups obtained from APST at the end of the distance education practice made to the experimental group. As a result of the t-test, p = .559 was calculated. As the calculated p-value is greater than .05, it was observed that there was no statistically significant difference between the scores of the experimental and control groups at the end of the practice to the experimental group [t(88)=.587, p=.559 >.05]. From the result obtained with this finding, it can be said that the teaching practice of the direct lecturing method through distance education is not effective in increasing the success of university students in solving algebra problems.

4.3. Findings and interpretation of the second sub-problem

It is thought that including the opinions of the students who evaluated the application process will help in the evaluation of the results obtained by the analysis of quantitative data in the teaching practice with distance education. For this reason, in this section, the opinions of university students taking algebra about the practice with distance education are examined in detail. For this purpose, categories and codes were created by the researchers, and their frequency and percentage values were given in tables. The qualitative findings related to the second sub-problem are given in the tables below. Since the practice is done by distance education, the regular participation of the students in the practice is important in terms of seeing the results of the research in detail. Table 8 shows that the majority of students (84%) attend classes regularly. However, almost half of the students' state that they encounter some difficulties in continuing the course.

Table 8. Students' Opinions on the Status of Continuing the Teaching Practice through Distance Education

Category	Codes	f	(%)
Participation in the class	I attended the classes regularly	42	84
	I attended the classes mostly	8	16
	Total	**50**	**100**
Difficulty attending the class	I did not have any difficulty	24	48
	I had difficulties	26	52
	Total	**50**	**100**

The reasons that make it difficult for the students to continue the class and their opinions about their solutions are given in Table 9.

Table 9. Students' Opinions on The Reasons That Make It Difficult to Attend The Course and Their Solutions

Category	Codes	f	(%)
Problems and causes	Internet-related problems	34	50.75
	Technical infrastructure / System related problems	20	29.85
	Special reasons	13	19.40
	Total	**67**	**100**
Problems solved		17	65.38
Problems mostly solved		9	34.61
	Total	**26**	**100**

From Table 9, it is seen that the reasons for the difficulties faced by the students in continuing the class are problems arising from the internet or technical infrastructure, and special reasons. From the written explanations and the results of the interviews, it was seen that the students generally listed the special reasons as "the necessity of sharing the computer, not being able to access the internet for economic reasons, not feeling safe on the internet, and being in the quarantine process due to the illness of themselves or their relatives during the epidemic". It is understood from Table 9 that a great majority (65.38%) of the students (52%) who stated that they encountered problems solved the problems. However, students who live in areas where

there is no internet access or access is difficult, or who cannot meet the necessary conditions due to economic reasons, also stated in the interviews that they have difficulties in continuing the class.

Table 10. Students' Opinions on Whether Distance Education is Sufficient to İncrease The Success of Solving Algebra Problems

Category	Codes	Sub-codes			
Sufficient (17)	Live lesson opportunity	Helping to understand the subject (8) Giving the opportunity to ask questions (4)	2	0.90	
	e-course documents and lecture videos	Making it easy to follow the lesson (2) Being very clear and understandable (10) Easy access to documents and videos (6) To be able to watch videos again (4)	2	0	
	More class hours	Discussion/repetition of questions and their solutions (11)	1	0	
	The efficiency of the lesson	Providing an efficient lesson environment (10)	0	.09	
	Instructor of the course	The lecture is clear and understandable (13) Communication/encouragement to participate in the lesson/motivation (14) Giving the opportunity to ask questions (13) Sharing lecture notes and lecture videos (15)	5	0	
		Total	**10**	**00**	
Insufficient (33)	The epistemological structure of the course	The structure of the course/difficulty/not easy to understand (11)	1	.43	
	During and after the live lesson	The decrease in the efficiency (effort - endeavor - success) obtained from the course/the efficiency depends on the student. (18) Learning in the classroom is easier and more effective (12) Inability to ask sufficient questions (10) Wanting to take notes in class (4) Wanting to use the board (11) Inability to be active in the class/not enough interaction (9) Live lessons that cannot be attended are very difficult to make up (3) Watching lecture videos is not enough (3)	0	7.30	
	Communication	Wanting to communicate face-to-face with the instructor of the course (9) Inability to communicate with friends/lack of communication (10)	9	2.83	

	Internet	Not always being able to attend live classes (5)		3.38
	Affective/Psychological reasons	Home/study environment negatively affecting motivation (10) Lack of motivation/concentration/timidity (19) Fear/anxiety/worry/lack of self-confidence (1) More responsibility on the student/ spending more effort/ student is responsible for their learning (8) Being distance education tiring (4) Being used to face-to-face education (1)	3	9.05
		Total	**48**	**00**

In Table 10, students' opinions regarding whether the distance education practices made for teaching algebra are sufficient or not are included. Students who think that the practices are sufficient form 34% of the students who participated in the practice. These students stated that they found the practice sufficient for reasons such as having the opportunity to attend live lessons, easy access to e-lesson documents and lecture videos, and that help to understand the lesson, making the lesson productive and increased lesson hours for answering questions from students. In addition, almost all of the students who found the practice sufficient stated that the instructor made an important contribution to this process. The students stated that they found the practice sufficient because the instructor's lecture was clear and understandable, communicated effectively, encouraged participation in the lesson, gave the opportunity to ask questions in the lessons, and shared the lecture notes. From this finding, it can be said that the instructor has important duties in the teaching of algebra in distance education.

The students in Table 10 think that the distance education practices for teaching algebra are not sufficient to form 66% of the students who participated in the practice. It is seen that 47% of the students' opinions expressing that the practice is not sufficient mostly focus on the factors that affect the efficiency of the lesson before, during, and after the live lesson. Secondly, it is seen that the opinions of the students who attribute the inadequacy of the practice to affective or psychological reasons form approximately 29% of the opinions in this category. Students who did not find the practice sufficient stated that their interest and motivation towards the lesson were negatively affected due to the comfort provided by the home or study environment. The students stated that they took their learning responsibilities by spending more effort and endeavor with the practice. However, it is understood from Table 10 that the students did not express these statements as positive opinions.

Table 11. Students' Opinions on the Advantages of Distance Education in An Algebra Course

Category	Codes	Subcodes	f	%
Advantages	Course/Lecture notes	Sharing lecture notes/ easy to access (12) Opportunity to come to class by prepared (2) Preparation of detailed notes helps to understand the lesson (8) Increasing the number of live lectures where question solutions and discussions take place (11) Live lessons (1)	34	39.08

Homeworks	The permanence of information as it is based on research and more studies (1) Recognizing the underlying deficiencies that make the lesson difficult to understand (2)	3	3.45
Gathering attention/ Focusing	No note-taking effort during the lesson makes it easier to focus on the lesson. (1)	1	1.15
Time	No time loss by taking notes during the lesson (1) No time loss on waking up early, getting on the bus, or getting to and from school (7) Opportunity to devote more time to studying (2)	10	11.5
e-course videos	Accessing lecture videos at any time (21)	21	24.13
Convenience	Connecting to the lesson at home/in a comfortable environment/from the current environment (7) Not experiencing physical difficulties experienced in face-to-face education (not accessing lecture notes, not seeing the board, sitting far-close) (1)	8	9.20
Economical	No expenses such as travel, food, and dormitory costs (4)	4	4.60
Psychological	Peace of mind (2) Feeling safe with the family (2) Listening to the lecture with the family/introducing friends and teachers to the family (1)	5	5.74
Use of technology	Conducting lessons using technology (1)	1	1.15
	Total	**87**	**100**

In Table 11, there are students' opinions about the advantages of teaching algebra courses via distance education. It is seen that the students generally consider the advantages of distance education that the lecture notes and lecture videos are prepared in detail, that they can be shared over the system and are easy to access, that the lessons are held simultaneously, that they can connect to the lessons from the environment they are in, and that there is no cost such as food and dormitory fees. On the other hand, in the interviews made with some students, they stated that they attended the class with the comfort of being in the home environment, but this affected their motivation negatively after a while and they could not be disciplined, and they also stated that distance education turned into a disadvantage.

Table 12. Students' Opinions on the Disadvantages of Distance Education in An Algebra Course

Category	Codes	Subcodes	f	%
Disadvantages	Gathering attention/ Focusing	Individual problems that cause the flow of the lesson to be disrupted during the live lesson (2) Listening to lectures by constantly looking at the computer screen (4) Inability to focus on the subject and question solutions due to not using the board (5) The comfort in the home environment cannot fully provide the course discipline/the absence of lesson environment/not being motivated/being stressed (23) Lesson follow-up becomes difficult as no notes are taken during the lesson (6) Thinking the course is difficult (8) Not wanting to attend the class (5) Internet outages/technical issues (16)	69	47.91
	Asking questions	Not enough opportunity to ask questions (4) Inability to express oneself fully and not being able to ask questions /hesitation (9) Not having the opportunity to get help from friends, to study together, and to discuss (10) Not feeling like in the classroom and a student (8)	31	1.53
	Communication/ socialization	Lack of adequate communication and socialization (22)	22	5.28
	Other	Inability to grasp the importance and seriousness of the class from distance/lack of discipline (6) Formation of fear and anxiety towards the lesson/being stressed (6) More effort by the student compared to face-to-face education (4) Being tiring (4) Thinking that constantly looking at your computer screen will cause health problems (2)	22	5.28
		Total	**144**	**100**

In Table 12, there are student opinions on the disadvantages of teaching algebra courses with distance education. In this table, it is seen that almost half of the students' opinions (47.91%) are gathered under the code of gathering attention and focusing. From this, it is seen that students, from the difficulties experienced by students in focusing and concentrating on the lesson in distance education, hold conducting courses through distance education responsible, and interpret this situation as the

disadvantage of distance education. It can be seen from Table 12 that students' opinions on other disadvantages of distance education are concentrated under the codes of asking questions, communication/socialization, and others.

Table 13. Students' Opinions on Teaching Algebra Courses with Distance Education

Category	Codes	f	%
Positive opinions	Algebra can be taught with distance education (9)	9	18
Negative opinions	Algebra should not be taught by distance education (32)	32	64
No difference	"If the algebra had been taught face to face, it would have been this much. I don't think there is any difference in understanding the lesson. " (5)	5	10
No idea	No opinion on the subject/not expressing an opinion (4)	4	8
	Total	**50**	**100**

In Table 13, the general opinions of the students about the algebra course being taught by distance education are given. According to Table 13, it is seen that more than half of the students (64%) think that it is not appropriate to teach algebra with distance education. The majority of the students stated that the distance education courses did not create a positive result for them and they did not find it appropriate to teach the algebra course via distance education. This shows that it is consistent with the opinions in Table 12 in which the students expressed the disadvantages of distance education. According to Table 13, there are 9 students (18%) who stated that the algebra course can be taught by distance education, and there are 5 students who stated that they would benefit from the course in the same way if it was done face to face.

5. Discussion

In this study, the effect of distance education on the success of university students taking algebra courses in solving algebra problems was examined and students' opinions about the practice were taken. In this study conducted on university students with a posttest control group quasi-experimental design, it was observed that the distance education practice was not effective in increasing students' success in solving algebra problems as a result of the parametric tests. As the calculated p-value is greater than .05, it has been observed that there is no significant difference between the posttest scores of the experimental and control groups at the end of the practice made to the experimental group. With this finding, it can be said that the practice of distance education is not effective in increasing students' success in solving algebra problems. Experimental group students who took lessons through distance education attended more lesson hours than control group students. Additional live lessons were made upon the request of the experimental group students. Consequently, the number of algebra course hours increased. Nevertheless, this fact did not enable the experimental group students to be more successful than the control group students in the problem-solving test conducted within the scope of group theory of algebra course. On the other hand, there was no significant difference between the achievement of the two groups in solving algebra problems. In this context, when evaluated in terms of teaching algebra - although it was a new subject - it is thought that if the experimental and control groups' course hours were equal, a significant difference might arise between the posttest achievement scores in favor of the control group. In addition, considering that despite the additional live lessons, the opinions of the majority of the experimental group students about the algebra course given through distance education were not positive, it can be said that the equal number of course hours in both groups would probably lead to such a result. This situation strengthens Keegan's (1996) view that distance education can be used as a supplement to face-to-face education. Despite the increase in the number of additional live lessons

in this study, there was no significant difference between the two groups. It should be considered that the psychological and social conditions of the experimental group students were influential in the emergence of this result, as stated in the opinions of experimental group students. Because it is known that motivation, cooperation with the group, group discussions, communication, and interaction play an essential role in learning (Doolittle, 1999, as cited in Altun, 2015; Skemp, 1986, cited in Altun 2015). In this study, experimental group students stated that they could not express themselves adequately during the distance education process, could not be motivated to study and lesson, failed to communicate adequately, and could not socialize. In this context, the difficulties experienced by the experimental group students in the distance education process - as they stated in their statements - might have affected their achievement. Therefore, it is thought that Cookson's (1989) view that students' psychological and social conditions in the distance education process should be examined, and sufficient studies on this subject should be performed as much as the technological infrastructure studies is valid. In addition, the results of this study show parallelism with the results of experimental studies by DePriter (2013) and Summerlin (2003). The results of this study show parallelism with the results of the experimental studies conducted by DePriter (2013) and Summerlin (2003).

When the literature is examined, it is seen that studies are indicating that some difficulties inherent in mathematics affect mathematics teaching. Difficulties arise in transferring mathematical ideas to students with symbols and graphics, especially in online lessons (Mayes, 2011). According to Engelbrecht and Harding (2004), another difficulty in learning mathematics through distance education is that technology itself is a disincentive. The fact that mathematics has a conceptual structure, that educators think that they can only convey these concepts in face-to-face classroom environments and that today's internet technology offers limited opportunities for displaying mathematical symbols prevents mathematics teaching from being carried out effectively through distance education (Engelbrecht & Harding, 2004). The abstract structure of algebra and its mostly proof-based nature may have made it difficult for university students to learn this course via distance education, as stated by Engelbrecht and Harding (2010) and Mayes (2011).

Studies show that abstract algebra course is perceived as difficult by students (Capaldi, 2014; Grassl & Mingus, 2007; Leron & Dubinsky, 1995). It is stated that one of the difficulties of teaching mathematics, especially in online courses, is that students feel more fear and anxiety in such learning environments (Bird & Morgan, 2003; Conrad, 2002; Hembree, 1990; Mensch, 2010). In this context, considering the opinions of the experimental group students, the fact that there was no significant difference in the success of solving algebra problems between the two groups supports the results of studies on similar subjects in the literature. In this study, the majority of the students stated that they had difficulty in understanding this course due to the combination of the abstract structure of the algebra course, its proof-based nature, and the various disadvantages of distance education. Although synchronous and asynchronous videos, lecture notes, and various documents are shared, students think that they cannot get enough efficiency from this course because they cannot discipline themselves as in face-to-face education. This situation can be explained by the possibility of various distractions due to the lack of full control of the teacher over teaching situations, which is one of the disadvantages of distance education. They also stated that they had difficulties in focusing on and continuing the lessons due to technological and internet-based difficulties and that it was very difficult to make up for the lessons that could not be attended. This situation draws attention to the importance of constructing the spiral structure between the components of distance education. Because success in distance education is achieved with a well-designed spiral structure (Demir, 2014; Nichols, 2003). In this context, it can be suggested to examine each of the components that make up the spiral structure in depth.

Various researchers propose different methods to overcome the difficulties that arise in the realization of mathematics teaching through distance education. To overcome these perceived difficulties, researchers have suggested approaches that use student-centered learning methods, especially in recent years (Hoffman, 2017). However, in a study that is not similar to the results of this study, Chinnappan (2006) stated that positive results were obtained by using discussion and collaborative teaching methods in the process of knowledge creation in online mathematics lessons with adult students. Two other studies that do not

show parallelism with the results of this study are those by Sugilar (2019) and Moreno-Guerrero et al. (2020). Sugilar (2019) stated in his study that the average mathematics achievement in the group that received face-to-face education was lower than the average of success in the group that received online education. Moreno-Guerrero et al. (2020) stated in their study that the e-learning method has positive results in learning mathematical subjects and mathematical concepts and achievement in mathematics, and that e-learning is more effective and applicable on secondary school students than the traditional explanatory method. Similarly, it can be said that the results of Yorgancı's (2014) study do not show parallelism with the results of this study.

While this study shows parallelism with the results of several studies in the literature on mathematics teaching, it does not show parallelism or similarity with the results of other studies. This situation can be interpreted as an indication of the fact that with the emergence of distance education technology, it has become a matter of debate whether the expected outcomes in mathematics teaching can be achieved (Krussel, n.d.).

When the opinions of the university students who participated in this study about doing the algebra course with distance education are evaluated with content analysis, it can be said that they support the results of the quantitative analysis. In this context, it is understood that the majority of the students stated that it is not appropriate to conduct the algebra course with distance education. A similar result emerges in the results of Stuiah et al.'s (2020) studies, in which students prefer face-to-face education instead of distance education. Similar opinions on the advantages and disadvantages stated in distance education studies in the literature (ex. Dumford & Miller, 2018; Koç, 2020; Naidu, 2019; Salomon, 1998) were also expressed by the students participating in this study.

When the findings are analyzed in detail in this study, it can be said that the results supporting the theories that constitute the theoretical infrastructure of distance education emerges. Therefore, in this section, student opinions are discussed in the context of distance education theories and studies. In this study, when the one-to-one interviews with the students and the written explanations of the students were examined, it was revealed that the students first thought about the disadvantages rather than the advantages of distance education. It has been understood that students generally do not know exactly what they should pay attention to in individual study and how they will work, and they have difficulty in taking responsibility for their learning. Some students interpreted this situation as a result of their habits to face-to-face education. As a result of these habits, the students stated that the subjects or concepts that can be understood more easily and quickly with the use of various methods in face-to-face education are more difficult and time-consuming to understand despite all the efforts made in distance education, and the assignments cannot be completed on time. The students agreed that the instructor of the course had very important contributions in the lecture, arrangement of the course environment, and the synchronous and asynchronous preparation and presentation of various course materials. However, it is understood from the quantitative and qualitative findings that all these efforts did not make a difference in increasing the success of students in solving problems in the algebra course.

Within the scope of the opinions of the students, they may have experienced conflicts in the distance education process because they are used to face-to-face education and the Covid-19 pandemic continues. Because some students, who are aware of this situation, stated that they could not be motivated to the lesson in distance education, they could not work adequately by disciplining themselves and they could not feel like a student. These opinions of the students support Moore's transactional distance theory. Because, in Moore's theory, the fact that students are physically far away does not mean that they are far from learning, but he stated that distance is caused by miscommunication and psychological factors that prevent learning. Some students explained the factors that hinder their learning as lack of communication, inability to work together, affective and psychological reasons. In addition, it was observed that students used various expressions to remind the importance of the community of inquiry theory by Garrison et al. (2003). Accordingly, the students stated that they could not feel like students, did

not want to react in the lesson, could not be motivated, and could not grasp the seriousness and importance of the distance lesson.

Some students stated that they worked hard, put more effort, and took more responsibility for their learning in this process. Students reflected these opinions from a more negative point of view. On the other hand, distance education theorists and researchers emphasize the opposite of this situation. Wedemeyer (1981, cited in Chaney, n. d.) states that student independence is the basis of distance education and that this independence should be adopted as a way of application in a technology-based system. Accordingly, the student should be independent of time and place, learning should be independent of the teacher, and the learner should take responsibility for learning. Instructors should also provide learning environments and resources to students in accordance with the principles of distance education (Sakshaug, 2000). Today, student-centered education approaches talk about the importance of students taking responsibility for their learning. For example, according to Moore (1989), the student should take responsibility for his learning and should decisively exhibit an active process with less help from the teacher. According to Holmberg (1997), an environment with effective communication and interaction ensures active participation in the lesson. In this context, the student is motivated by a sense of belonging, can express himself and his thoughts comfortably in the lesson, and learning becomes more enjoyable. In this study, it is understood from the negative opinions of most students about the distance education process that a learning environment that supports the statements of Moore (1989) and Holmberg (1997) could not be fully established. For example, most of the students stated that they did not feel like they belonged to the course, they could not ask questions easily and they had difficulty in expressing themselves. This result is in parallel with the view that affective features are neglected in virtual learning environments (Garrison et al, 2000). Cookson (1989) explained the reason for this is that distance education studies mostly deal with the system infrastructure. On the other hand, in this study, students stated that one of the difficulties they experienced regarding the process was the internet and technological infrastructure. Özkaraca's (2005) opinion that in synchronous education environments, together with appropriate technological infrastructure, the parties must have sufficient technical equipment and have the competence to use technology is important in this context.

Conclusion and Recommendations

In this study, the effect of distance education on the success of university students taking algebra courses in solving algebra problems was examined and students' opinions about the practice were taken. In this study conducted on university students with a posttest control group quasi-experimental design, it was observed that the distance education practice was not effective in increasing students' success in solving algebra problems as a result of the parametric tests. As the calculated p-value is greater than .05, it has been observed that there is no significant difference between the posttest scores of the experimental and control groups at the end of the practice made to the experimental group. With this finding, it can be said that the practice of distance education is not effective in increasing students' success in solving algebra problems.

When the opinions of the experimental group students about the practice were examined, it was seen that they stated that distance education had various advantages, but they mostly experienced various difficulties. The students considered the advantages of distance education as the detailed preparation of lecture notes and lecture videos, easy to share and access via the system, simultaneous lectures, the opportunity to connect to the lecture from the current environment, and no meal and dormitory expenses. Students stated the disadvantages of distance education as not being able to express themselves fully, not being able to ask questions, not feeling like in the classroom, not being able to do group study, not being motivated to the lesson, not being able to study disciplined and regularly, not being disciplined due to the comfort of a home environment, internet-related difficulties, inadequate communication, and socialization.

It is recommended that the results of this study be repeated with different methods and larger sample groups. In particular, it is recommended to carry out detailed studies that will reveal the reasons for student opinions on the distance education process in an algebra course. On the other hand, the result of this study suggests that the views of Keegan (1996) and Sutiah et al. (2020) expressing that distance education is complementary to traditional education are important. Another reason for this view is that in the study conducted by Sugilar (2019), it was found that the success average of the group participating in face-to-face and online training together was higher than the average of success of other groups.

As a result, it can be suggested to conduct studies in which distance education is used as a complement to traditional education in the context of the quantitative and qualitative results revealed by this study and to compare the results. In addition, it can be suggested to examine the mostly negative opinions of university students towards field courses in distance education with different methods and techniques.

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Appendix 1.

Semi-Structured Interview Form (SSIF)

1) Did you continue the algebra course given through distance education? Did you encounter any difficulties in continuing the course? If so, what kind of problem or difficulty did you experience? What do you think might be the reason for this difficulty? How did you solve the problem?

2) Please explain your views on whether the distance education given for this course is sufficient or not.

3) Do you think there are any advantages of distance education for algebra courses? If so, what are these advantages according to you? Explain your answer.

4) Do you think there are any disadvantages of distance education for algebra courses? If so, what are these disadvantages in your opinion? Explain your answer.

5) What kind of work did you do to succeed in this course? Have you done any further study different from what was done in this distance education course? If so, explain what you did.

6) Write your positive thoughts about this course given through distance education.

7) Write your criticism for this course given through distance education.

8) Do you have any suggestions for this course, which is given through distance education, to make it effective? What is it, if any? Explain your views on this matter.

9) Compare distance education and face-to-face education based on your experience.

10) Please add anything you want to add.