INTEGRATING MATHEMATICS AND ICT OBJECTIVES FOR ALGORITHMIC THINKING, PROBLEM SOLVING SKILLS, AND EPISTEMOLOGICAL BELIEFS

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DECLARATION OF ORIGINALITY

I, Dilek Turan, certify that

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ABSTRACT

Integrating Mathematics and ICT Objectives for Algorithmic Thinking, Problem Solving Skills, and Epistemological Beliefs

This mixed method study assessed the effectiveness of an integrated Mathematics and ICT curriculum designed according to the problem-based Arc of Learning framework, for student learning, and investigated its effects on the 5th-graders' problem solving and algorithmic thinking skills, as well as mathematics related epistemological beliefs. PBL activities were developed by the researcher that integrated two units in the mathematics curriculum, and one unit in the ICT curriculum. The participants were 5^{th} grade students (*n=23*) in the experimental group while 6^{th} graders (*n*=21) in the control group, and 193 5th-8th graders comprised the participants for the investigation of the middle schoolers' mathematics related epistemological beliefs. Quantitative data were collected through Mathematics Oriented Epistemological Beliefs Scale (MOEBS); algorithmic thinking and problem-solving skills test (ATPS test), and mathematics and ICT unit tests. The qualitative data were collected through weekly assignments and students' artifacts during the implementation. The results indicated that the students improved their ATPS skills at the end of the implementation. They also increased their Mathematics and ICT unit exam scores. The qualitative data supported the results from the quantitative data by showing that the students who increased their ATPS scores significantly also improved their scores in the Math and ICT unit exams. An examination of student artifacts in group work provided evidence for the learning process and the improvement the students experienced throughout the 5-week program. As for epistemological beliefs, no significant difference was found before and after the implementation in the MOEBS scores.

ÖZET

Algoritmik Düşünme, Problem Çözme Becerileri ve Epistemolojik İnançlar için Matematik ve Bilişim Kazanımlarının Bütünleştirilmesi

Karma yöntem ile yürütülen bu çalışma, probleme dayalı "Öğrenme Yayı" çerçevesine göre tasarlanmış bütünleşik Matematik ve BTY müfredatının 5. sınıf öğrencilerinin epistemolojik inançları, içerik bilgisi ve algoritmik düşünme ve problem çözme becerileri üzerindeki etkisini araştırmıştır. Matematik müfredatından 2 ünite ile BTY dersinden bir ünitenin entegre edilerek araştırmacı tarafından tasarlanan öğretim programı oluşturulmuştur. Türkiye'nin kırsal bir bölgesindeki ortaokul öğrencilerinin epistemolojik inanç düzeylerini araştırmak için bölgedeki 193 ortaokul öğrencisi katılımcı olmuş ve oluşturulan programın etkisini incelemek için deney grubu olarak 5. sınıf (n=23) ve kontrol grubu olarak 6. sınıf öğrencileri (n=21) çalışmaya katılmıştır. Matematik Odaklı Epistemolojik İnançlar Ölçeği (MOEBS); Algoritmik düşünme ve problem çözme becerileri testi (ATPS), matematik ve BTY ünite testleri aracılığıyla nicel veri, uygulama sürecinde haftalık değerlendirmeler ve ders esnasında toplanan öğrenci ürünleri nitel veri olarak toplanmıştır. Sonuçlar, 5 hafta boyunca bütünleşmiş müfredat derslerine katılan öğrencilerin, kontrol grubuna göre algoritmik düşünme ve problem çözme becerilerini önemli ölçüde geliştirdiğini göstermiştir. Ayrıca deney grubu, yani 5. sınıf öğrencileri, uygulama sonrası Matematik ve BTY ünite sınav puanlarını yükseltmiştir. Nitel veriler de ATPS puanlarını önemli ölçüde artıran öğrencilerin matematikteki çok adımlı problemleri çözmede daha başarılı olduklarını desteklemektedir. Öte yandan, nicel verilere göre deney grubunda uygulama sonrasında epistemolojik inançlar açısından anlamlı bir gelişme olmadığı bulunmuştur.

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CHAPTER 1

INTRODUCTION

It would not be possible to learn Mathematics by learning just the rules for mathematical operations—learners need to see the reasoning behind the rules they apply. As Polya's (1973) well-known cookbook analogy indicates, providing the ingredients and the steps to use the ingredients allows room for the individual's own understanding, while a strict application of a "mathematical recipe" would not. On the flipside, if a mathematics instructor follows the procedures of the cookbook, then learners will not be able to connect the rules and they will quickly forget what strategies they used to solve the problem (Polya, 1973).

To solve a problem, learners need both conceptual knowledge, the understanding of the relation among the concepts, and procedural knowledge, the ability to implement the steps to be used to solve the problem (Hakim & Yasmadi, 2021; Rittle-Johnson et al., 2001). These two abilities, i.e. procedural and conceptual knowledge are linked to each other and one iteratively affects the other (Canobi et al., 2003; Rittle-Johnson et al., 2001; Schneider et al., 2011). Thus, instruction which aims to improve either one of these types of knowledge is not desirable, in mathematics education the instruction needs to fulfill both (Schneider et al., 2011). Since through algorithmic thinking the ability to execute procedural knowledge develops, it is believed that algorithmic thinking advances conceptual understanding (Abramovich, 2015). Therefore, instruction focusing on algorithmic thinking and conceptual knowledge will help learners with problem-solving achievement.

Mostly students are given problems that are easy to decide which algorithm will be used, so learners can easily determine the algorithm, and sometimes by using their procedural knowledge they will solve the problem (Amalia et al., 2017). For instance, if students read a sentence that includes “total amount of” and two numbers as the amounts, then they directly add these two numbers because they are taught to do so, and they “know” that they will find the right answer. However, what if learners encounter an unfamiliar problem?

Learners seem to memorize how to solve an equation; therefore, even if they did not conceptually understand what they need to do to solve the equation if they have practiced well, then they can easily solve it using their procedural knowledge. However, it is clearly pointed out that when students are faced with a story problem since they cannot understand what is asked, they cannot decide which operations they need to solve the problem (Alibali et al., 2014). In addition, Freudenthal (1981) claimed that most people are taught the rules and if they know something is true then they do not even try to question that information. He argued that many learners do not even attempt to think about the reasons for what they learned; for instance, if someone will multiply a number by 100 then they quickly add two zeros to the number without thinking about the reason for adding zeros (Freudenthal, 1981). Therefore, it is important to provide problems that allow learners to move beyond the memorized rules without thinking about the reasoning behind the rules.

Even though it is accepted that story problems are needed to develop conceptual understanding, sometimes these problems might not be a “real” problem for learners. To accept a problem as a “real” one it needs to be difficult enough to solve, and learners need to feel that they have to find an authentic way to overcome the obstacle they faced (Polya, 1981). While trying to find a way, learners will start to remember what they have learned related to the problem, connect this knowledge, and transfer the knowledge into the new situation; thus, this will enable the development of mathematical understanding rather than just practicing the rules (Lambdin, 2003).

Learners need to be aware that there are plenty of perspectives to solve a complex problem. Rather than just repeating what they have been taught, they need to search for new strategies because doing mathematics is not only mimicking what the teacher did during a problem-solving process. It requires comprehending the problem, creating new strategies, applying those strategies, and checking whether the solution works or makes sense (Walle et al., 2010). To create new strategies, it is necessary to synthesize what is given in the problem, what knowledge is needed and helpful, and what is already known by the learner (Polya, 1973).

Hearing their peers' ideas to solve a problem helps the learners to create alternative ideas and more importantly, see that there is not only one way to accomplish a goal, or in this case, to solve the problem. There are many ways, which may or may not result in the achievement of the goal, but all are crucial for the path of the solution. As Linn, Bell, and Davis (2004) stated, many textbooks contain just the answer to the problem, and many research studies have focused only on the way that leads to the correct solution, however, knowledge is not gained in one single shot. Experts may also be mistaken, yet clarifying this misunderstanding leads them to find the desired path.

On the other hand, if learners believe that there is just one way to reach the "right" solution, or experts/ mathematics textbooks are always right, or the mathematical "rules" they were taught are unchangeable, then they will have difficulties in solving "new generation story problems." These beliefs tend to stem from learners' general epistemological beliefs as well as their domain-specific, i.e. mathematics-related epistemological beliefs.

An important issue here is what kind of instructional processes should be planned, or what an instructor should do when learners encounter ill-structured, contextualized, and unfamiliar problems, in other words, “the real problems.” Papert (1980) claims that learning depends on the culture and environment that the knowledge occurs in. The materials used for teaching should meaningfully hold together, and not be dissociated. When teaching mathematics, the environment should encourage a culture of math, and contain a rationale for learning it. Polya (1981) also stated that algebra is a language, if someone knows how to talk in the algebraic language then they translate English and algebraic language (Polya, 1981). Papert (1980) stated in his seminal work *Mindstorms* that any student can learn French if he grows up in France rather than just taking the French class in another country, so any student can learn mathematics in Mathland. Therefore, the environment needs to provide a rationale to learn mathematics and encourage learners to think about this learning, which will not only take place in the classroom but will last their whole life.

Problem-based learning (PBL) is a learning environment model that offers authentic problems enabling learners to transfer their knowledge by discussion to solve the problem (Hmelo, 1998). Compared to traditional instruction, PBL follows the process of problem-solving suggested by Polya (1973), which is understanding the problem, analyzing for planning, implementing the plan, and lastly looking back to reflect what has been done and check whether it makes sense. Additionally, this problem-solving process occurs in a social environment by constructing knowledge with peers, therefore it helps cognitive development (Downing et al., 2009).

While students can solve an equation by using their existing procedural knowledge without understanding the meaning of the equation when they encounter word problems, they have difficulty in transforming the problem into an algorithm, so it becomes difficult for them to reach a solution (Savery, 2006). Therefore, instructions emphasizing either conceptual or procedural knowledge are not effective on problem-solving achievement. One of the reasons for this difficulty in problem-solving is that students try to repeat the method they were taught mot-a-mot, instead of trying to find solution paths other than the method they memorized, seeing that there is more than one solution (Freudenthal, 1981; Walle et al. 2010). This perception stems from the students' epistemological beliefs; students who believe that the information comes from a single source or that it is the only truth do not go beyond the memorized method to reach the solution (Gu, 2016; Hofer, 2000).

1.1 Purpose of the study

The purpose of this study is to investigate to examine the effect of instructional design that integrates mathematics and ICT objectives within the Arc of Learning framework on 5th-grade students' problem-solving and algorithmic thinking skills and epistemological beliefs. A secondary purpose is to examine the relationship between epistemological beliefs and mathematical problem-solving skills . The Arc of learning framework is adopted as a PBL model to design and implement an integrated math and ICT learning environment based on two specific units from the 5th grade Math and ICT curriculum.

1.2 Significance of the study

Problem-solving skill, which is important in mathematics education (Freudenthal, 1981), and closely related algorithmic thinking are essential for both mathematics and computer science. To sophisticated problem-solving skills it is crucial to improve both conceptual and procedural knowledge. Additionally, epistemological beliefs also effect that skill, because as students' epistemological beliefs in mathematics become more naïve, their belief that there is only one answer or that the answer comes directly from a single source increase while solving problems, and they cannot be successful in complex problems because they do not seek alternative ways.

Also, according to an OECD report examining Math curricula from19 countries, much of the Mathematics curricula still relies on basic skills, while educators recommend algorithmic reasoning, complex problems encountered in real-life situations, and 21^{st} century skills such as communication and creativity (W. H. Schmidt et al., 2022). The study also draws attention to how important mathematical literacy was during the covid-19 pandemic. The follow-up of the data published daily, the mask requirements taken according to these data, or most importantly, the decisions to be vaccinated are given as examples for this mathematical literacy. When the mathematics curricula and textbooks of 19 countries are compared, it is seen that although there are targets such as mathematical literacy, algorithmic reasoning, and solving complex problems in the curriculum, there are not sufficient appropriate activities or questions in the textbooks. For this reason, algorithmic reasoning, and higher order thinking were targeted in this study, and integrated with the ICT curriculum.

Although there are many studies of epistemological beliefs and mathematical problem-solving, only a small number of these studies involved an implementation specifically addressing learners' needs at middle school level. Also, even though the effects of PBL environment on the learners' epistemological beliefs were widely studied, the majority of the studies were about science topics. The current study will focus on designing instruction for developing mathematical problem solving and algorithmic thinking skills and epistemological beliefs of middle school students. The study's contribution will be its integrated approach to essentially related skills in two different realms in the curriculum, and its research focus on both skills' development and epistemological beliefs. It is hoped that the findings from the study can shed light on how two related subjects can be integrated and guidelines can be offered for both teachers and policymakers for an integrated curriculum of mathematics and ICT courses in case positive effects are obtained.

CHAPTER 2

LITERATURE REVIEW

The literature review chapter presents theories of epistemological beliefs, algorithmic thinking, mathematical problem solving and the methodology for increasing these beliefs and kills. The theoretical framework of this study is based on epistemological beliefs in learning, problem-based learning, and teaching and learning of algorithmic thinking and problem-solving skills, First, epistemological beliefs and mathematical epistemological beliefs are discussed, then algorithmic thinking and problem-solving abilities are explained. Lastly, the problem-based learning (PBL) model and arc of learning framework, which is a PBL framework, are reviewed.

2.1 Epistemological beliefs

Epistemology is a branch of philosophy and simply defined as the study of knowledge and knowing, yet it is also a field that educational researchers are interested in (Bråten, 2010). Epistemological beliefs are important in education because they affect how people think and reason both in everyday matters and in academic life (Depaepe et al., 2014; Kuhn & Weinstock, 2012).

The development of epistemological beliefs is widely researched. Schommer (1993) showed that students' epistemological beliefs in simple and certain knowledge and quick learning develop through high school. Later, Kuhn et al.(2000) designed two studies to understand the order of development among different judgment domains, namely, personal taste, aesthetics, value, and truth. The first study involved three younger groups, one young adult group, and two mature adult groups that differ in terms of intellectual ability. The level of the beliefs is changeable in terms of the judgment domains; and as expected, while the transition from the multiplist to evaluativist was realized, the changes from absolutist to multiplist could not be observed. Therefore, researchers conducted another study with 2nd and 3rd graders. Although this study revealed that the transition from absolutist to multiplist happens very quickly and it is hard to capture someone in the middle of that transition, these two studies proved that there was a development through the ages and education levels.

Kurt (2009) conducted research with 1557 students from 5th, 6th, 8th, and 10th grades and she found that there is a statistically significant effect of grade levels of students on their epistemological beliefs, and 8th graders had higher epistemological beliefs than 5th graders. Another study conducted in Turkey with 440 high school students who attended grades 10-12th , grade investigated students' epistemological beliefs through age and whether there is a correlation between epistemological beliefs and attitude toward studying (Önen, 2011). The analysis showed that students' epistemological beliefs developed as their age increased, while the 10th-grade students scored lowest in epistemological beliefs, the 12th-graders scored the highest means. However, some researchers found a negative correlation between the grade level and epistemological beliefs. For instance, Cakir and Korkmaz (2019) collected data from 438 middle school students in a rural region in Turkey, and showed that the epistemological beliefs of 5th-graders were higher than the beliefs of 8th-graders. Moreover, in a research study executed with 427 students attending 4th, 6th, and 8th-grades, it is concluded that there was a correlation between the grade level and epistemological beliefs; yet, it was the 8th graders who scored the lowest means in knowledge justification and knowledge development factors of epistemological beliefs (Boz et al., 2011). As the reason for this result, the researchers stated that it could be a teaching method. Students' epistemological beliefs can develop in instructional methods, such as inquiry-based approaches; Therefore, Boz et al. (2011) suggested similar research with students attending classes with different types of instructions.

Further, the link between epistemological beliefs and learning is investigated by many researchers in the educational context (Berding et al., 2017; Jena & Chakraborty, 2018; Önen, 2011). Onen (2011) found a positive correlation between students' epistemological beliefs' and their attitudes toward studying; which means that as the level of epistemological belief increased, their attitudes towards studying became more positive. Another study on epistemological beliefs and learning approaches was conducted by Ozkal et al. (2009) with 1152 8th grade students. As a result of the study, it was revealed that students with more advanced epistemological beliefs used more advanced learning strategies which lead to deeper processing of knowledge. On the other hand, Saunders (1998) stated that students with fixed epistemological beliefs favored rote learning (Saunders, 1998 as cited in Özkal et al., 2009). In another study examining the relationship between epistemological belief and learning approach, 20 8th grade students were selected out of 202 8th-graders to be interviewed according to an initial questionnaire, and it was found that students with more constructivist's knowledge, that is, sophisticated epistemological beliefs, used more meaningful strategies in their understanding in science. Students with empiricist knowledge, that is, students who have naive epistemological beliefs, tend to use more rote-like strategies in their science learning processes (Tsai, 1998).

In addition to the relation between epistemological beliefs and learning approaches or attitudes toward studying, the link between mathematical problem-solving attitudes and epistemological beliefs was also researched. At this point, the question of whether epistemological beliefs can be increased through instruction is raised. Kienhues et al. (2008) conducted a study that aims to examine the effects of a short-term intervention on domain-specific epistemological beliefs with 58 university students. Half of the students had more naive beliefs than the other half according to the pretest. The intervention group received refutational epistemological instruction and the control group received non-challenging instruction (without any opposite ideas), and the students were randomly assigned to these groups. As a result, even in a short-term intervention, which was only text-based, the domain-specific epistemological beliefs of the students in the intervention group changed in a positive direction to a more sophisticated view (Kienhues et al., 2008).

The relationship between academic achievement and epistemological beliefs is another area of research in epistemological belief studies. Schommer (1993) investigated the effect of secondary school students' epistemological beliefs on their academic performance by looking at the general point averages. It was found that the belief in quick learning was related to low-level comprehension, and this lead to low-level academic achievement. The study highlighted the need to investigate the relationship between epistemological beliefs and different subjects in high school, rather than general point averages (Schommer, 1993). Furthermore, Kurt (2009) found that the epistemological beliefs were significantly correlated with the students' majors, and it is accepted that students who major in mathematics and science fields have more sophisticated epistemological beliefs in knowledge justification than students attending social-science fields (Kurt, 2009). Therefore, in the next section epistemological beliefs in mathematics will be examined.

2.1.1 Mathematical epistemological beliefs

Many students would say that mathematics cannot be discovered or achieved by reasoning, but one must be instructed to learn it. Research has shown that students tend to think that memorization is important in learning mathematics because mathematical problem solving needs a predetermined sequence of steps or memorization of formulas (Steiner, 2007). Therefore, since their beliefs about the nature of knowledge, i.e., epistemological beliefs are naive, they would not attempt to find a strategy on their own to solve an unfamiliar problem.

Muis (2004) called the beliefs that make a contribution to learning "availing", and the beliefs that have no influence, or negatively impact learning "non-availing" beliefs. Non-availing beliefs about mathematics were the students' beliefs that mathematics only includes rules and procedures; that mathematics is about reaching the correct answer; and that in mathematics, one needs to get the knowledge from an authority. In a study with 159 college-level students, it was found that more availing beliefs about the importance of understanding and usefulness of mathematics positively correlated with exam performance, based on data from Mathematical Beliefs Scale and final exam results in an Intermediate Algebra course (Steiner, 2007).

Schommer-Aikins et al. (2005) investigated whether epistemological beliefs are related to mathematical problem-solving beliefs and how these two belief systems are related to students' reading, mathematical problem solving, and overall GPA. They found that students who are epistemological "quick believers" assume that all assignments should be done in a short time. If they face more challenging and time-consuming problems, they may quit and move on to different activities when the time they allocated to problem-solving ends. Also, it was shown that students focused on a fixed belief think that if they could not solve the problem immediately then they will never achieve it because had they had the ability to do so, they would have solved it immediately (Schommer et al., 2005).

Although it is argued that age is a factor in the development of epistemological beliefs, there are other factors, related to the sophistication of beliefs, such as education level (Kuhn et al., 2000; Schommer-Aikins et al., 2005; Schommer, 1990, 1993). Moreover, beyond the level of education and experience, the type of instruction that enables students to realize the uncertainties or the controversial ideas about a topic (Kienhues et al., 2008; Valanides & Angeli, 2005) and a collaborative learning environment seems to impact the development of epistemological beliefs (Akbay et al., 2018; Hofer, 2001).

2.2 Algorithmic thinking and problem-solving abilities

Algorithmic thinking can be defined as a system of thinking that enables the construction of intermediate tasks, and the sequence of steps to reach a goal--the final task (Cooper et al., 2000; Kalelioğlu et al., 2016). In other words, algorithmic thinking refers to defining a problem, analyzing it, planning the path to solve the analyzed sub-problems, implementing the plan, and evaluating the whole process (Futschek, 2006). Common examples of algorithms in everyday life might be following a recipe to cook or one's route from home to school; it is clear that these activities have steps to follow (Brown, 2015; Kalelioğlu et al., 2016). Even though it is accepted that algorithmic thinking is as old as humans because of daily problems humans face, it has become an area of study with the development of computer science (Geda & Biró, 2020), and how computing is taught.

Although algorithmic thinking is a term used since the 1950s and used for step-by-step problem solving, it is considered a major component of computational thinking (Grover et al., 2015), even if it is sometimes used interchangeably with computational thinking (J. Mezak & Pejic Papak, 2019; Jasminka Mezak & Petra, 2018).

2.2.1 Algorithmic thinking and mathematical achievement

In his seminal work Mindstorms, Papert (1980) argued that to increase mathematical understanding beyond school mathematics, a learning environment is required that offers students the opportunity to create problem-solving strategies by "thinking like a computer" It is widely accepted that mathematical thinking and algorithmic thinking skills are correlated (Knuth, 1985). After interviewing 5 mathematicians with PhDs in the field Lockwood et al. (2016) found that mathematicians use the term algorithmic thinking interchangeably with the term procedural knowledge. At this point, it is beneficial to mention that they did not explain procedural knowledge only as following the steps given, but also as deciding which path is worth following and which steps will not be effective compared to others. Thus it might be said that (deep) procedural knowledge includes comprehension of the problem solving and decision-making processes (Star, 2005).

According to a meta-analysis conducted by Lei et al. (2020), even though it is expected that the computational thinking and academic achievement, especially in mathematics, science, and language, is expected to be positively correlated, research in the last decade revealed unequivocal results. There are studies in the literature that found no significant relationship between algorithmic thinking, a dimension of computational thinking, and academic achievement, however, this finding has not been tested with middle school or younger students, also these studies were not examining the mathematics achievement even though they looked for the GPA, and are not in the majority (Doleck et al., 2017; Lei et al., 2020; Shell et al., 2015).

On the other hand, there are studies that show that mathematical achievement is related to computational thinking, which is built on algorithmic thinking skills (Alotaibi & Alyahya, 2019; En et al., 2021; Grover et al., 2015; Mindetbay et al., 2019; Özgür, 2020). According to the results of the research conducted by En et al. (2021) with 153 university-level STEM students, it was observed that there is a relationship between computational thinking and the level of academic success in STEM, except for the dimension of cooperation. It has been concluded that one of the related dimensions of computational thinking was algorithmic thinking skills, successful students get high points on algorithmic thinking questions of the Computational Thinking Scale, and low-achieving students have low algorithmic thinking averages.

A study was conducted with 405 students from 5th grade to 12th grade and a positive relationship was detected between academic achievement in mathematics and the level of computational thinking (Özgür, 2020). As for younger age groups, in the study with participants from 5th to 12th grades Özgür (2020) found that students with high computational thinking skills were also successful in mathematics and science. In addition, Özgür (2020) revealed that students who are successful in mathematics and science say that they understand concepts more easily by formulating concepts while learning mathematics or that they can quickly set up equations while finding the result, which is related to algorithmic thinking. Further, Alyahya and Alotaibi (2019), found that according to 46 8th graders' achievement in TIMMS (Trends in International Mathematics and Science Study), mathematics achievement and computational skills of 8th graders are positively correlated; and when they examined the dimensions of computational thinking, they found that the biggest factor in success is the problem-solving dimension and the next important factor is algorithmic thinking. Moreover, in a study with 775 8th-grade students, it was concluded that achievement in algebra can predict computational thinking; which were analyzed through GPA scores and a multiple choice computational thinking skills test (Mindetbay et al., 2019). It has also been shown that the computational thinking skill levels of 4th graders tend to be positively correlated with their basic mathematical knowledge levels (Lewis & Shah, 2012). Yet, there is a need to explore the relation between the algorithmic thinking dimension of computational thinking and mathematical achievement, because even if there are studies about these two variables, as previous studies were conducted in the context of computational thinking skills (Yavuz Mumcu & Mumcu, 2018).

There is a limited number of research studies to describe the algorithmic thinking of middle school students (Mumcu & Yıldız, 2018) and examine whether there is a relation between middle school students' algorithmic thinking skills and their mathematical achievements. Mumcu and Yıldız (2018) conducted research with 138 fifth and sixth-grade students to make a contribution to the gap, they found that 6th graders had better algorithmic thinking scores than 5th graders; and they also found that there is a small positive correlation between mathematical achievement and algorithmic thinking skill. Also, since there is a lack of studies examining algorithmic thinking in the younger age group, the researchers suggested that there is a need for research at middle school level in this area with different theoretical framework (Mumcu & Yıldız, 2018)

2.2.2 Algorithmic thinking and grade level

In a meta-analysis of 34 studies Lei et al. (2020), found that the group with the strongest relationship between computational thinking skills and academic achievement was primary school students, then the middle school students, and those with the weakest relationship were high school students and older participants. Therefore, Lei et al. (2020) deduced that age is an indicator of the correlation between computer thinking and achievement , Thus, it is worth to investigate the grade level in terms of the algorithmic thinking dimension of computational thinking, after the correlation with the academic achievement is explored.

There are research studies confirming that algorithmic thinking skills are positively correlated with age. In a study conducted with 1251 Spanish students, participants from 5th to 10th grades were selected as participants and both computational thinking skills and cognitive abilities (spatial ability, reasoning ability, problem-solving ability) that might be related to computational thinking were investigated. According to the results of the study, the computational thinking skills of the participants increased as they got older. In addition it was also revealed that the cognitive ability with the highest correlation of computational thinking skill was problem solving ability (Román-González et al., 2017). Computational thinking skills of 6th graders were more advanced than that of the 5th graders according to a study conducted with 13784 fifth and 6th graders from different cities in Turkey (Gülbahar et al., 2015). According to Gülbahar et al. (2015)in the study conducted at the all middle school levels, it was found that the lowest computational thinking score was in the 5th grade students, while the highest average was found in the 8th grade students. Also, a research conducted with 138 fifth and sixth grade students showed that 6th graders benefit their algorithmic thinking skills more than the 5th graders according to the data gathered via Algorithmic Thinking Test created by the researcher herself. (Mumcu & Yıldız, 2018).

On the other hand, some researchers found the contrary, the younger students had higher algorithmic thinking scores than the older students (Atmatzidou & Demetriadis, 2016; Korkmaz et al., 2015). Korkmaz et al. (2015) found that among 1306 college level students, algorithmic thinking skills increase as the age increases for the first three years of the college; however, contrary to expectations, a decline was observed in senior and graduate students, and the seniors scored lowest algorithmic thinking scores were belong to. Similarly, Oluk (2017) examined the relationship between computational thinking skills, age, mathematical intelligence perception, and mathematics achievement using data collected from 1070 students. The Computational Thinking Levels Scale was used to investigate algorithmic thinking. The results showed that algorithmic thinking skills decrease as age increases. It is seen that 4th graders have the highest algorithmic thinking scores among these students from 4th, 6th, 8th and 12th grades, while the lowest scores were scored by the 12th graders (Oluk, 2017).

On the other hand, Atmatzidou and Demetris (2016) showed that 15-year-old junior high students scored higher in algorithmic thinking than the 18-year-old vocational school students, after participation in an 11-week computational thinking skills development program, which was an educational robotics learning activity for both age groups using Lego Mindstorms NXT 2.0 educational robotics kit. The findings were based on data collected through interviews, questionnaires, and think aloud protocols.

2.2.3 Algorithmic thinking development through instruction

Voogt et al. (2015) advocated that the integration of computational thinking into the curriculum still has shortcomings. Especially trying to teach computational thinking skills only in computer science courses is a major deficiency. The computational thinking skills are needed to be internalized by each student because these are necessary for 21st century skills and also for success in other disciplines (Barr & Stephenson, 2011; Grover et al., 2015; Korkmaz et al., 2015; Voogt et al., 2015)In addition to clarifying the definition and scope of computational thinking, Voogt et al. (2015) argued that researchers should study which computational thinking skills are needed in which disciplines, and which sub-skills can be developed through an integrated curriculum of those disciplines.

How to teach computational thinking skills is still an issue in the field as to whether it should be a studied as a separate subject or be integrated with other disciplines (Voogt et al., 2015). Barr and Stephenson (2011) described how components of computational thinking concepts, such as data collection and algorithmic thinking, were referred or examined in different fields; for instance, in mathematics, science, or language arts. They found that integrating computational thinking into other areas of the curriculum helps students to understand and to improve their computational vocabulary. Also, they suggested that an instruction method having a teamwork in the learning environment supports enhancement in some components of computational thinking, such as problem-based learning model.

One of the most important components of computational thinking skills for both mathematics and computer science is algorithmic thinking (Kallia et al., 2021). Algorithmic thinking improvement through many school subjects is related to instructing in appropriate teaching method (Doleck et al., 2017). It seems that with more sophisticated algorithmic thinking, learners become more successful on the problems in the domains that require reasoning ability such as mathematics and science (J. Mezak & Pejic Papak, 2019). In the study conducted by Korkmaz et al. (2015) with college level students, the relationship between the student's grade level and algorithmic thinking skills was examined. This study also showed that algorithmic thinking, which is one of the factors of computational thinking, is related to the department they are enrolled in. The results showed that the highest algorithmic thinking skill levels have measured with the individuals who were enrolled in a mathematics-related program (Korkmaz et al., 2015). This finding provides evidence for Wing (2008)'s argument for why computational thinking skills should be taught before undergraduate or graduate levels, and that these skills needed to be gained during elementary or middle school.

Furthermore, research also showed that the teaching methods developing algorithmic thinking also improved learners' mathematical problem-solving ability (Demir & Cevahir, 2020; Walle et al., 2010). In Demir and Cevahir's (2020) study with 60 high school students, teaching students programming increased their algorithmic thinking which was measured by the algorithm knowledge test created by the researchers and problem-solving skills. In addition, it not only increased their achievement in computer science, but also increased their achievement in mathematics.

To increase mathematical problem-solving achievement, two different aspects, mathematical epistemological beliefs and algorithmic thinking are discussed so far. Both algorithmic thinking and mathematical epistemological beliefs might be developed through instruction designed particularly for this purpose. Therefore, a problem-based learning framework will be explained next.

2.3 Problem-based learning

Problem-based learning (PBL) is an approach that requires students to solve complex problems. Since the problems are complex, authentic, and ill-structured, students need to collaborate, to think about their alternative ideas, and to synthesize what they know (Lu et al., 2018). In PBL, learning occurs in a cycle with a beginning point of defining the problem and an endpoint of reflection, and after the reflection, the loop starts again (Barrows, 1986). PBL is adjusted according to different goals and educational contexts in terms of the problem types, the role of the teacher, the skill targeted, and budget or time constraints (Barrows, 1986). The common features of PBL, on the other hand, are being learner-centered, containing complex problems, and the instructors have the role of facilitator, and learners work in groups collaboratively (Walker et al., 2011).

To create an effective PBL environment it is crucial to have an integration among different topics (between subjects or within-subject), maintain collaboration and teamwork, integrate the newly generated knowledge with knowledge students already have, and synthesize that knowledge to move forward on the way to problem-solving, reflecting on what is learned via both self and peer assessment, through engagement with real-life problems and situations (Lu et al., 2018).

As already mentioned, PBL has been implemented in various areas. The first implementation was in medical education and the aim was to observe how medical school students employ their theoretical knowledge in realistic situations (Barrows, 1986). Later, PBL was used in different faculties such as engineering, architecture, and education (Walker & Leary, 2009). Lu et al. (2018) argue that there seems to be a shift from learning experiences focused on content and presentation to individual and collaborative learning in time. This progress, of course, explains the evolution and development of designs in learning environments and the use of the PBL model in the educational context.

The role of the teacher in a PBL environment is another critical issue. It is already pointed out that teachers have the role of "facilitator," what a facilitator does will be explained below. At the beginning of the problem-solving process, the facilitators make their expertise (both how to solve a problem and in the context of the problem) available to students and scaffold them, and at some point, they start to decrease their support. Other than support, facilitators keep an eye on the discussions among learners and help them to progress through the discussion. The help may take the form of asking prompt questions or asking learners to clarify their ideas and thinking (Lu et al., 2018). Also, facilitators can wrap up learners' thinking if learners need to connect ideas among tasks or steps of the problem, which will maintain inferences in the learning process (Li & Chen, 2018). Lastly, the role of the facilitators includes guiding learners to evaluate what they have done and what their peers have done.

The learner is at the center of PBL and this enables self-directed learning, too. At the beginning of the PBL process, after learners define the problem, they try to connect their existing knowledge with the problem. Then they need to decide what information they need to fill the gaps on the way of solving it. Later, the learner searches for the needed information and collaborates with peers to accomplish this aim. Learners are not all alone through these steps, the facilitators support them (Belland et al., 2019).

Explanatory research was aimed to interpret the behaviors of the group members during two weeks of a PBL course conducted by Belland et al. (2009), As a result of a survey, observations, and interviews with students it was found that within a group, the abilities of the participants are different from each other, and all participants try to fill each other’s gaps and help each other to overcome the difficulties they faced. Collaboration makes their thinking visible because via discussions with each other they clarify their ideas and have a chance to hear others' ideas to make negotiations and revisions (Lu et al., 2018). According to the case study in which Cerezo (2004) investigated middle school students' views on the effect of problem-based learning in mathematics and science lessons, it was found that students got better in mathematical problem solving over time. As a reason for this progress, it was revealed that the students thought that working together, no matter how overwhelming, was very useful in solving problems.

Lastly, learners’ perceptions of PBL were also investigated. Sahin (2009) tried to determine predictors of undergraduate students’ scores in introductory physics courses that made use of the problem-based learning (PBL) approach or conventional lectures. Although some of the students saw PBL as an effective approach for critical thinking, communication, and problem-solving skills, others indicated that PBL was an ineffective instructional approach because of insufficient time to prepare for module exams, not being able to manage self-directed learning, and negative tutor and guidance behavior during the PBL sessions (Sahin, 2009). These findings underscore the difficulty and importance of implementing PBL appropriately.

There are two complementary explanations for the question of why PBL is effective. The first one is the “activation-elaboration hypothesis” which means that during the problem-solving process each step forms a basis for the next step, and this enables knowledge building (Lu et al., 2018; H. G. Schmidt et al., 2011). The second, “situational interest hypothesis”, claims that real-world and context increases students' engagement with the problem, and this enables students to maintain their interest in searching for new information through the problem-solving process (Hidi & Renninger, 2006; Lu et al., 2018; H. G. Schmidt et al., 2011).

Problem-based learning model was researched in different disciplines, such as science, medical fields, history, law, education, and mathematics (Alper & Altun, 2014). Conventional mathematics teaching mostly results in only rote learning or following just what the teacher did and it creates passive students in the learning process; however, problem-based learning enables students to solve problems with higher order mathematical capabilities in a collaborative way (Widyatiningtyas et al., 2015). According to Widyatiningtyas et al. (2015), after a PBL versus conventional modeled mathematics courses for 140 10th-grade students, it was found that students who attended the PBL classes had higher mathematical critical thinking scores than those who attended conventional mathematics classes. Also, it is known that students' problem solving abilities are also improving as they encounter errors, deficiencies and problems in a PBL environment (Roh, 2019).

2.3.1 PBL in online instruction

To create a PBL environment using online tools and increase mathematics achievement in such a course delivered remotely, not only to the content of the course, but also the students' creative and critical thinking skills will need to be addressed. These skills will be important because, it has been claimed that epistemological beliefs are related to students' mathematical problem-solving skills, and as Hofer (2001) stated, a prerequisite for high critical thinking skills is more advanced epistemological beliefs.

Fauziah (2013) explored how creative thinking amongst college-level Physics students and pre-service science teachers can be fostered using PBL in an online Physics course. The experimental group pursued all the PBL learning activities (i.e., collaborative, independent, self-directed, and reflective learning), while the control group was taught in a traditional lecture-based environment. Both groups worked online over a Learning Management System, Moodle. The online course lasted 16 weeks and 61 students participated. Participants' creative thinking was measured by Torrance Test of Creativity Thinking (TTCT), while their critical thinking was assessed using Watson Glaser Critical Thinking Appraisal (WGCTA). A statistically significant difference was found between the PBL and the control groups in critical thinking, which is considered an outcome of sophisticated epistemological beliefs according to Hofer's (2001) review of epistemology research. The PBL group performed significantly better in 3 of the 4 elements of creativity, which are flexibility, originality, and elaboration. No difference was observed between the two groups regarding fluency.

Yu et al.(2015) examined the changes in undergraduate students' ability to evaluate a situation critically and academic achievement after learning in three different environments, which were traditional lecture format, PBL, and blended PBL. A critical thinking inventory and a comprehensive course content test of 45 questions were the data collection instruments of this study. During the second week of the 18 weeks course, all three groups completed a California Critical Thinking Disposition Inventory (CCTDI) and pre-comprehensive exams. The traditional group participated in a face-to-face course that mainly consisted of the instructor's presentation using PowerPoint. The PBL class, on the other hand, worked in groups of 5 on a problem related to the topics of the week. The blended PBL group worked on the same problems as the PBL group, however, they were more flexible in terms of time. For instance, they did the whole group discussion via the chat room feature of an LMS, e-Campus, and wrote the reflection paper outside of class time as homework, rather than during the face-to-face class time. All three classes filled out the post-CCTDI in the 17th week and the post-comprehension exam in the final week. Although there was no significant difference among the three groups in terms of critical thinking, the findings showed that the traditional group had the lowest achievement scores on the posttest. The blended PBL group had significantly higher achievement posttest scores than that of the PBL and the traditional groups (Yu et al., 2015). It was argued that the sophistication level of epistemological beliefs predicts the critical thinking level, that is the high level of critical thinking requires sophisticated epistemological beliefs (Akbay et al., 2018; Hofer, 2001).

In another study with undergraduate students, Şendağ and Ferhan Odabaşi (2009) examined how using the PBL approach in an online course delivered over an LMS (i.e. Moodle) affected content knowledge and critical thinking skills (CTS) in a pre-test post-test control and experimental group design. 40 undergraduate students participated in the study for one semester, and they were randomly assigned to two groups, experimental and control. The experimental group attended the online PBL course while the control group attended the online instructor-led course. Data was gathered through a multiple-choice content knowledge test and a critical thinking scale. The findings showed that learning in the online PBL group had a significant effect on increasing critical thinking skills. Although both groups increased their post-test scores in terms of content knowledge, there was no significant difference between the groups according to ANOVA results.

2.3.2 Arc of learning framework

Although PBL as a teaching approach provides general guidelines for supporting problem-solving skills, the instructor may need a structured framework to implement this model, as specific steps in the process are not defined in detail. Since the model depends on complex problems when launching these problems the instructor may follow Van de Walle’s three phases: the first phase is introducing the problem, the second is enhancing students to work on the problem, and in the last one, the instructor “orchestrates” the class to arrive at the solution via scaffolding students to make mathematical connections between what they already knew and what they are learning (K. J. Jackson et al., 2012). Based on this instructional model, the Arc of Learning framework was developed by the Connected Mathematics Project team at Michigan State University in the early 1990s (Edson et al., 2019).

Edson et al. (2019) aimed to show how the Arc of learning framework emerged and developed through the feedback of the teachers and learning outcomes of the students. The authors explain the process that started from the Middle Grades Mathematics Project (MGMP) to the Connected Mathematics Project, version 3 (CMP). It started as a guide for teachers to create a problem-based teaching model in 3 phases, which are launch, explore, and summarize. Today, it is not only a teachers' guide but also an entire curriculum both for teachers and students with digital support and an implementation website. The researchers researched various aspects of teaching and learning Math through group and individual work in problem-based learning environments, and according to the findings for over 30 years they created the Arc of Learning framework (Edson et al., 2019).

The curriculum aimed for students to develop both conceptual and procedural knowledge, therefore, the CMP evolved to contain problems that help students to improve their understanding (i.e., students need to understand what operation they are going to use to solve a problem) and their procedural knowledge (i.e., what algorithm they need to construct to conduct the operation). The Arc of Learning framework leads students to have more sophisticated reasoning instead of practicing and memorizing the procedures, by articulating a learning process in 5 phases. The phases are Introduction – Setting the Stage, Exploration – Mucking About, Analysis – Going Deeper, Synthesis – Looking Across, and Abstraction – Going Beyond.

Arc of Learning for Connected Mathematics				
Introducing *Setting the Scene*	**Exploring** *Mucking About*	**Analyzing** *Going Deeper*	**Synthesizing** *Looking Across*	**Abstracting** *Going Beyond*
The problem provides an opportunity to…				
• reveal the mathematical theme for the unit • informally highlight the key mathematical concepts in the unit • assess prior understandings related to the goals of the unit	• establish a platform for developing key aspects of the understanding of the concepts and strategies • explore (consider) a context that students can use to build, connect, and retrieve mathematical understandings	• make connections between concepts and representations • examine nuances in key aspects of the core mathematical ideas often with a variety of contextual situations	• recognize core ideas across multiple contextual or problem situations • begin to consolidate and refine emerging mathematical understanding(s) into a coherent structure	• make judgments about which representations, operations, rules, or relationships are useful across various contexts • look back on prior learning to generalize, extend, and abstract the underlying mathematical structure • assess understandings at a more general level

Connecting
Reflecting
Assessing
Mathematical Practices

Fig. 1 The Arc of Learning framework
(Edson, Philips, Slanger-Grant, & Stewart, 2019)

Although some problems serve for two phases, none of the problems can be coded for more than two consecutive phases for a big mathematical idea. The Arc of Learning framework is an “ergonomic resource” for curriculum design and use (Edson et al., 2019). Even though this framework was constructed for redesigning the CMP curriculum, it is suggested for use in any PBL curriculum, because the main target is sequencing the problems in the learning process for the best acquisition of the big idea of the topic/unit (Edson et al., 2019).

Previous research focused on the extent to which the CMP approach was an effective alternative to what was conventionally done in Math instruction. In a study that compared 7^{th}-grade students' proportional reasoning Ben-Chaim, et al. (1997) compared two different instructional approaches: Connected Mathematics and traditional curriculum. Students in both groups were asked to answer complex problems about the proportional reasoning. Even though before the one-year instruction the control group had slightly better scores than the CMP group, after the intervention the CMP seventh grade students outperformed the control group (53% vs. 28%) on solving complex problems. and they could provide good quality written and oral explanations. One year after this research, the same research procedures were repeated with both 7^{th} and 8^{th} graders. The previous study had focused on only one subcategory of the topic proportion, with this research the results showed a broader impact on proportional reasoning. The findings showed that in addition to a greater frequency of correct answers and reasoning, CMP students seemed to have developed a greater ability to articulate their thinking. It was found that CMP students had a broader and more flexible collection of strategies to solve a problem than the control group (Ben-Chaim et al., 1997).

As the CMP approach began being adopted by teachers in various schools, student perspectives were also examined regarding the then new reform-based curricula in teaching Math. The students found themselves more successful in real-life problems and indicated that mathematics was important in daily life, as well as their future career. In addition, students thought that mathematics became fun as they solve difficult problems, and solving these problems was more fun than solving practical questions, and that working together had a great impact on their learning (Bay et al., 1999).

An extensive research conducted over a long period of time and with large numbers of students, Cain (2002) worked with 3500 students enrolled in grades 5 – 8 in low-achieving schools in one of the southern states of the Louisiana. 34 teachers from 4 different middle schools used the CMP curriculum. The teachers were from a variety of backgrounds and experience levels, some had a master's degree, some had 30 years of experience, and some were novice teachers. Iowa Test of Basic Skills test data and the Louisiana Education Assessment Program of mathematics data were used for the quantitative analysis. For all of the schools, the students who enrolled in the CMP curriculum outperformed those who did not attended CMP classes on the high-stake exams (Cain, 2002).

In another study of the impact of CMP curriculum in high-stakes exams, Bray (2005) examined the mathematics results of the state achievement test (Tennessee Comprehensive Assessment Program test) administered at the end of each year, between grades 6 – 8, for approximately 3000 students who were in the Connected Mathematics Program curriculum for 3 years. According to the findings of comparison among the data gathered end of each year, a significant positive difference was detected in test scores at the end of the 3rd year in the program, although there was no significant difference at the end of the 1st and 2nd years. The author concluded that the longer the students were instructed in the CMP curriculum, the more successful they were, and suggested that such curriculum practices should be done for a long time (Bray, 2005).

In a more recent study investigating how curriculum influences Math instruction, 579 Math lessons were observed in various middle schools over a three-year period (Moyer et al., 2011). Approximately half of the 50 teachers adopted the CMP curriculum, and the other half were using a traditional (non-CMP) curriculum. The conceptual emphasis, the procedural emphasis, and the learning environment were the factors in the qualitative analysis. The findings showed that the CMP curriculum emphasized the conceptual aspect of the content, while the non-CMP curriculum focused on the procedural aspect. Further, the CMP curriculum yielded more opportunities to create a collaborative learning environment than the non-CMP curriculum. The CMP teachers made use of group work more than twice as the non-CMP teachers (Moyer et al., 2011).

2.4 PBL and epistemological beliefs

Researchers also studied if and how instruction changed students' epistemological beliefs. Muis and Duffy (2013) researched whether instruction can change students' epistemological beliefs and whether this change would be a predictor of an increase in achievement levels. 61 graduate-level students participated in a quasi-experimental study over a 12-week semester. Both the control and the experimental groups had the same learning materials, the professors of both groups prepared the syllabus, materials, and lectures together; the only difference was the type of the presentation of the lectures. In the intervention group, students were prompted to answer how they found the solution of a given problem, or why they thought that it was the correct solution; in other words, the instruction in the intervention group was based on the critical thinking of the content. The results showed that in the intervention group, students' use of critical thinking strategies significantly increased between the 4th and 8th weeks, with significant differences occurring between groups at week 8, while the control group maintained consistency (Muis & Duffy, 2013).

The effects of PBL on the students' epistemological beliefs is also studied in the literature. There seems to be a positive correlation between the two (Belland et al., 2019; Gu, 2016). In a study with 7th graders conducted by Belland et al. (2019), the students were expected to develop solutions in a three-week PBL unit, to improve the water quality of a river from a stakeholder's perspective by working in groups of 3-4. Students were trying to determine the reasons for poor water quality, evaluate the arguments they developed, and provide a solution for this problem from the stakeholder's perspective, as farmers, state government, or common citizens. During the three-week unit, the students discussed in their groups to reach a solution for both the stakeholder perspective and the county perspective. The teacher guided the students to develop their arguments and facilitated reflection and reasoning. Students responded to a 4-dimensions epistemic belief scale developed by Elder (1999) as pre and post-test, where the dimensions comprised whether knowledge was certain, changing and evolving, came from authority or came from reasoning. The results of both the quantitative and qualitative analyses showed that participation in PBL led to a significant enhancement of epistemic beliefs among high and average-achieving students.

Gu (2016) designed an exploratory mixed-method study to investigate the effects of a PBL unit on 7th - 11th-grade students' epistemic beliefs and whether epistemic beliefs are changed during PBL. For two weeks, the students tried to answer the question "Is there a water quality problem in Green Valley?" which was the main problem in the PB unit. Based on the descriptive analysis, 11th graders' epistemic beliefs were more sophisticated on the post-test than on the pre-test. The reasons behind the improvement may be that the students experienced a complex process of conducting investigations, collecting information from multiple sources, and integrating these conflicting information to support the argument they created. This study showed that the level of sophistication of middle and high school students' epistemic beliefs may increase even in two weeks of PBL implementation. Further, students with more sophisticated epistemic beliefs were more successful during the problem-solving process because they collected information from multiple sources, made sense of that information, and tried to find evidence to support their claims.

However, there are some exceptions to the findings reported above. Gu (2016) also found that while some students' epistemological beliefs were developed, some did not change, and even some of the students' level of epistemological beliefs decreased at posttest. Belland et al. (2019) showed that PBL did not have any positive impact among low achieving students, while Yu et al. (2015) demonstrated a significant improvement in content knowledge after a 17-weeks of a blended PBL course, they could not find any development in critical thinking. They interpreted this unexpected finding based on the low to moderate reliability of the CCTDI scale, a self-reported inventory they used to measure critical thinking. In contrast, Sendağ and Odabaşi (2009) showed that learning in the online PBL group did not have a significant effect on the students' content knowledge acquisition scores, while it had on critical thinking. However, the researchers indicated that the reason they had not found an effect on the content knowledge might be the duration of the intervention; for instance, Yu et al. (2015) had a 17-week intervention, whereas the implementation conducted by Sendağ and Odabası (2019) lasted only 8 weeks.

In light of the literature reviewed above, problem-based learning can be a proper teaching model, if implemented and assessed appropriately. As Fosnot and Perry (1996) argued, learning will occur not by avoiding contradiction, but by creating a space for learners' own and contradictory ideas that causes a disequilibrium, which they will spend an effort to resolve. One way of creating such an environment is the problem-based learning model, which can provide a means for developing problem solving and algorithmic thinking skills. The Arc of Learning framework provides a means to operationalize this model and aims to develop both conceptual and procedural knowledge. This framework can also offer an opportunity to improve algorithmic thinking skills (Edson et al., 2019).

In this study, the Arc of Learning (based on CMP) was adopted as a model for PBL design and implementation for an appropriate integration of Math and ICT curriculum delivered online remotely, during a school year infested with school closings.

2.5 Math and ICT integration

The use of instructional technologies in PBL Math and -Science instruction was found beneficial (Mezak & Papak, 2019). However, in this study, since algorithmic thinking and problem solving are common targets for both the Math and ICT curricula, an integrated approach was adopted that went beyond the integration of some ICT tools while teaching Math, and identified and addressed common Math and ICT learning objectives.

Curriculum integration has been shown to offer students opportunities to overcome the difficulties they faced in one area as they tried to solve problems from another integrated area though the learning process (Wall & Leckie, 2017). In studies that addressed Math and ICT integration, the focus has traditionally been the integration of information and communication technologies as a tool in mathematics lessons (Das, 2019; Jackson, 2017; Nikolopoulou & Diamantidis, 2014). For instance, Nikolopoulou and Diamantidis (2014) created a series of lessons that integrated Math and Physics courses in a PBL environment using GeoGebra, a well-known Geometry software. There are many examples of studies that focus on the use of an ICT tools and softwares, such as Geogebra, Cabri 3D, or other Math applications (Das, 2019; M. Jackson, 2017; Yazlık, 2019; Yuliardi et al., 2021).

On the other hand, computational thinking (CT) skills, which have increased in importance over the last decade, and algorithmic thinking, which is a critical part of CT, have an important place in the learning objectives of the ICT or CS courses, and can overlap with the learning objectives of the mathematics course (Fisler et al., 2021; Pei et al., 2018). Indeed, when the Turkish middle school national curriculum is examined, it can be seen that the learning objectives of the ICT and mathematics courses overlap (TTKB, 2018). More recently, studies have been conducted with younger students on the integration of the curriculum of Mathematics and ICT courses, rather than integration of only technology tools (Israel & Lash, 2020; Strickland et al., 2021) However, further research is still needed that focus on appropriate integration at various levels of schooling.

The aim of this study was to develop fifth-graders' problem-solving and algorithmic thinking skills in a PBL learning environment designed according to the Arc of Learning framework, based on the integrated objectives of the Math and ICT class in middle school. It was expected that this approach might have a positive influence on students' epistemological thinking, in addition to content knowledge and problem solving and algorithmic thinking skills. Therefore, the effect of this integrated PBL approach on fifth graders' mathematical epistemological beliefs was also investigated.

The following were the research questions addressed in this study:

i. Is there a correlation between grade level and mathematics oriented epistemological beliefs in 5^{th} – 8^{th} graders in a small school district in a rural province of Turkey?

ii. Is there a significant difference in 5^{th} graders' mathematics oriented epistemological beliefs when compared to a control group after participation in a remotely delivered online implementation of a PBL based integrated Math and ICT instruction in a rural school?

iii. In what ways and to what extent do the 5^{th} graders' algorithmic thinking and problem-solving skills relate to the online implementation of PBL-based integrated Math and ICT instruction ?

   - Is there a significant difference in 5^{th} graders' algorithmic thinking and problem-solving skills at the end of the implementation based on a within groups comparison?
   - Is there a statistically significant difference in 5^{th} graders' algorithmic thinking and problem-solving skills when compared to a control group?
   - Is there a statistically significant difference in 5^{th} graders' mathematics and ICT unit exam scores after the implementation?

iv. What was the learning process of the 5^{th} graders throughout the online implementation based on their artifacts and responses to weekly questions?

CHAPTER 3

METHOD

In this chapter, research design, setting and participants of the study, implementation, data collection instruments and procedures, and finally data analysis are described.

3.1 Research design

A mixed-method triangulation research design was used to assess the effectiveness of a problem-based integrated Math and ICT unit for student learning, and to investigate whether it correlates with the algorithmic thinking and problem-solving skills, as well as mathematical epistemological beliefs. Mixed method research is a research design that combines and integrates multiple method types to answer the research questions by collecting, analyzing, and discussing both qualitative and quantitative data (Creswell, 2015). This mixed-method triangulation research adopted the triangulation design convergence model, where both quantitative and qualitative data were given equal emphasis to draw valid conclusions (Creswell, 2006; Creswell & Plano Clark, 2011).

The data collected via the weekly assignments and students' artifacts during the implementation were defined as qualitative data, by quantifying these two data sets researcher could analyze the learning progress of participants of the implementation group. The quantification also enabled the correlation analysis among the quantitative data collected through two different tests. The quantitative data enabled the analysis of the relation among the mathematics-related epistemological beliefs, algorithmic thinking and problem-solving skills, and mathematics and ICT achievement on the integrated units; whereas the qualitative data helped to explore the effectiveness of the integrated PBL based lesson plans, specifically in terms of the group work during the learning process, all conducted remotely using videoconferencing, instant messaging and online forms. The qualitative data also supported the quantitative analysis about student achievement and improvement of skills.

3.2 Setting and participants

The participants for the first research question comprised middle school students in the school district where the researcher worked in the province of Aksaray, For the rest of the research questions, the participants were fifth and sixth-grade students in the middle school where the researcher worked as a mathematics and ICT teacher.

For the second and third research questions, the experimental group consisted of 29 fifth-grade students who were taught by the researcher. The school is located in a small town in Aksaray, central Anatolia, and serves mainly children from low SES families. As four villages in the district do not have a middle school, children from these villages also attend the school. The total number of students in the school is 96, and there is only one section at each grade level. According to the student information prepared and collected by the school administration at the beginning of the academic year, many students have large families and there is more than one student at home. Also, based on the demographic questionnaire of this study, access to devices required to participate in online classes over the Covid-19 pandemic was limited, as the devices were shared with siblings. In addition, there is an internet infrastructure problem in some of the villages where students live, so approximately 40% of the students had limited internet quotas to attend classes. Therefore, the maximum number of attendees was 23 for the experimental group.

The control group consisted of the 21 sixth-grade students in the same school, Although 6th graders' mathematics objectives differ from the 5th graders', it was possible to have 6th graders serve as a control group for three reasons: 1) The 6th graders did not have ICT classes the previous year due to the lack of teachers, and therefore the ICT objectives at this level were the same as those at the 5th-grade level; 2) Even though the average age difference between the 5th and 6th grade students is generally 10 months, for over 1/3 of the 5th graders the difference was less than 6 months; 3) The research questions are not directly about the curricular content per se, but about problem-solving and algorithmic thinking skills, and mathematical epistemological beliefs. To ensure comparability of the two groups, the mathematical epistemological beliefs questionnaire and algorithmic thinking and problem-solving tests were conducted at the beginning of the study with both 5th and 6th graders. An independent samples t-test was executed to compare the scores from the algorithmic thinking and problem-solving test, and no significant difference was found between the 5th graders (M = 5.92, SD = 3.658) and the 6th graders (M = 8.09, SD = 5.847); t(44) = -1.526, p = .134. The two groups' scores from the mathematical epistemological beliefs pre-test, showed no significant difference either, between the 5th graders (M = 93.8, SD = 11.125) and 6th graders (M = 96.944, SD = 9.168); t(44) = -.944, p = .351.

3.3 Implementation

The units entitled “Triangles and Quadrilaterals,” and “Metric Conversions” in the mathematics curriculum, and the unit on “Problem solving and Coding” in the ICT curriculum were selected for implementation, because these two units have common objectives in terms of problem-solving and algorithmic thinking, and thus provide an opportunity for integrating the two fields to support student learning. The instructional design was based on the Arc of Learning framework. The implementation lasted for 5 weeks, 7 hours each week.

Following the ethics committee's approval for research from Boğaziçi University, permission was obtained from the Aksaray-Güzelyurt District National Education Directorate to carry out the survey and tests. After securing the approvals, Mathematics Oriented Epistemological Belief Scale (MOEBS) was carried out at all grade levels, except special education classes, in 6 middle schools in the district. In addition to MOEBS, experimental and control groups also took the algorithmic thinking and problem-solving test, and the experimental group was applied the mathematics and ICT exams before the implementation. These three instruments were used as post-tests at the end of the study. The experimental group also received a feedback questionnaire about the implementation.

3.3.1 Design of instruction

The design of the unit comprises investigations based on the Arc of Learning framework. Each objective in the "Triangles and Quadrilaterals" unit is defined as a separate investigation, and these investigations include different types of problems according to their sub-objectives. At the end of the investigation of each week, there was a section for mathematical reflection aimed to help students express what they needed to learn through the week in terms of the determined objective, and they answered specific questions about the objectives of the week. As mentioned in the literature review section above, the Arc of learning framework constitutes a five-step learning arc, namely, introducing (setting the scene), exploring (mucking about), analyzing (going deeper), synthesizing (looking across), and abstracting (going beyond). Table 1 below shows the problems of the lesson plan and what role these problems have in terms of the objectives of the course.

Since this implementation was applied during the covid-19 period, all activities were designed to be delivered remotely using video-conferencing and other online communication tools. However, in the last week of the implementation, , the school switched to hybrid education as mandated by the Ministry of National Education, so some of the activities of that week were carried out face-to-face for all of the students.

Table 1. Weekly Investigations

Week	week 1		week 2		week 3		week 4		week 5	
Lesson	ICT	Math	ICT	Math	ICT	Math	ICT	Math	ICT	Math
Objectives	Drawing flowchart Eliminating errors on a flowchart	Qualifications & naming of polygons	Analyzing problem Realizing the steps to solve the problem	Classification of triangles	Analyzing the problem Solving the problem by following the steps	Classification of quadrilaterals	Block-based coding Creating algorithm in a block-based coding platform	Sum of interior angles of triangles and quadrilaterals	Block-based coding Creating algorithm in a block-based coding platform m	Converting metric units Calculating the perimeter of triangles & quadrilaterals
	Route of the Robot	Which one is a polygon?	Tangram	Angles of the clock	The cups	The quadrilateral family	Blockly introduction	Triple Triangles	Distances in the maze	Metric conversion
	Flowchart entangled	Tangram Algorithm	Variables	Pitching the tent	Creating Polygons	The sitting arrangement	Blockly Puzzle	From triangles to quadrilaterals		The wooden frame- Cont.
Activities	What is the name of that polygon?	Mystery of Diagonals-Part1		Designing a slide		Code.org Quadrilateral design	Hungry bird	The wooden frame		Race in the school background
		Mystery of Diagonals		Triangle Table		Mathematical Reflection		Mathematical Reflection		Mathematical Reflection
		Mathematical Reflection		Mathematical Reflection						

Note. The activity names were created by the researcher.

The activities implemented over the 5-week period in the Math and ICT courses are listed in Appendix L. Additionally, the table in Appendix L includes whether the activity was a group work or not, which online tool was used, in which online tool the answers were collected, how many answers were collected, and lastly, the objectives in Math and ICT curriculum targeted.

Table 2 below shows which problem in the unit supports which problem-solving skill addressed in the Arc of Learning. To illustrate, the first problem in the introduction step in the first investigation constituted a robot in a certain location that attempts to go to a point the location of which will be determined relative to another point and needs to decide the path to reach the target. The “Robot's Route flowchart” activity from the ICT textbook is adapted to check understanding of an algorithm flow in the ICT lesson and of the position of one point relative to another in the Math lesson. For the development of epistemological beliefs, different views need to be brought up. Therefore, the question has been designed to include alternative routes in order to show the existence of different answers. (see Appendices N and O for this and other sample problems).

Table 2. Arc of Learning for Grade 5 Unit on Triangles and Quadrilaterals

	Introducing (setting the scene)	Exploring (mucking about)	Analyzing (going deeper)	Synthesizing (looking across)	Abstracting (going beyond)
* Robot's Route	x				
Which one is a polygon?		X			
* Entangled Flowchart		X			
*Name the polygon		X	X		
Tangram Algorithm		X	X		
Mystery of Diagonals			X		
Mathematical Reflection		X			
*Tangram	x	X			
*Variables		X	x		
Angles of the clock		X	x		
Pitching the tent		X	x		
Designing a slide			x		
Triangle Table			x	x	
Mathematical Reflection			x		
*The Cups			x	X	
The quadrilateral family			x	X	
*Creating Polygons			x		
The sitting arrangement			x	x	
Code.org Quadrilateral design				x	
Mathematical Reflection			x		
*Blockly introduction	x			x	
*Blockly Puzzle	x	X			
*Hungry bird			x		
Triple Triangles			x	X	
From triangles to quadrilaterals			X	x	
The wooden frame				x	
Mathematical Reflection				x	
*Distances in the maze			x		
Metric conversion			x	X	
The wooden frame- Cont.				X	X
Race in the school background				X	X
Mathematical Reflection					X

Note. The stars represent activities in ICT lessons.

According to the Arc of Learning framework, students are expected to verbalize mathematically what they have learned during the investigation and what conclusion they reached. Therefore, before the reflection problems, there were also activities/problems that students were required to think about what they have learned through the week, some of which are based on *Elementary and Middle School Mathematics: Teaching Developmentally*, by Walle, Karp and Bay-Williams (2010). For instance, below can be seen the "Triangle table" from week 2:

a. *Draw proper triangles in the blanks in the table below.*

	Equilateral triangle	**isosceles triangle**	**scalene triangle**
right triangle			
Acute triangle			
obtuse triangle			

b. *Two places in the table cannot be filled, which two could you not draw a suitable triangle? Explain why.*

3.3.1.1 Online tools.

The commonly used GeoGebra was integrated into several parts of the instructional design in this study. In addition, other mathematical software and applications were integrated. During the Covid-19 semester, the use of hands-on manipulatives had to be decreased, but there were online alternatives including specialized mathematical simulation websites such as "mathigon.org" and "phet.colorado.edu"; the websites that are created for online activities and games such as “learningapps.org” and “wordwall.net”; the websites that are created to teach coding, such as “code.org” and “blockly.games”; and the websites that are not designed for educational purposes but could be used in distance education, such as Google drawings and “padlet.com”. These were all integrated as part of the instructional design.

3.4 Data collection instruments

There are five types of instruments in this study; Mathematics Oriented Epistemological Beliefs Scale (MOEBS); algorithmic thinking and problem-solving skills test (ATPS henceforth), mathematics and ICT unit tests, weekly assignments, and students’ artifacts during the implementation. (see Appendices B, C, and D)

3.4.1 Mathematics oriented epistemological beliefs scale (MOEBS)

The Mathematics Oriented Epistemological Beliefs Scale was developed by Ilhan and Cetin (2013). The scale includes 27 items, divided into three factors, namely, the belief that learning depends on effort (BLDE), the belief that learning depends on talent (BLDT), and the belief that there is only one truth (BTOOT). For BLDE and BLDT, there are 10-items in each, and there are 7 items for BTOOT. It is a Likert-type scale ranging from one “I strongly disagree” to five “I strongly agree.”

A higher BLDE value and lower BLDT and BTOOT values are interpreted as more sophisticated epistemological beliefs, based on İlhan and Çetin (2013). In order to create a total epistemological beliefs score, the BLDT and BTOOT values are reversed in the calculation of a MOEBS score. The higher the total MOEBS score, the more sophisticated the students’ mathematics-oriented epistemological beliefs.

Since the MOEBS is created for high school students, there were some words in five items that 5th graders may not be familiar with. Therefore, the students' Turkish teacher, who also worked at the same school as the researcher, reviewed the items, and suggested to change 1 word in 4 of the items. In addition, the researcher consulted the authors who designed the MOEBS regarding appropriateness of the scale for middle school students. The authors first identified 2 items, other than the Turkish teacher's mentioned, as possibly problematic, these were discussed in detail by themselves, and again, the students' Turkish teacher was consulted. Finally, necessary changes were made, and those two problematic items were not removed. The Cronbach alpha for reliability of this slightly modified version was calculated, and it was found .737, based on the data from 227 middle school students who responded during the first part of this study.

3.4.2 Algorithmic thinking and problem-solving skills test & pilot study

The Algorithmic Thinking and Problem Solving (ATPS) test was prepared by the researcher based on the items in the STEM ability test, created by Arıkan and Erktin (2020) to assess 4th-grade students' ability. The ATPS scale consisted of ten items, five of which are about algorithmic thinking ability and the other five are about problem-solving ability. The first five questions were based on and adapted from the first and second questions in Arıkan and Erktin's (2020) test, addressing algorithmic thinking ability, while the other five were based on the 14th and 16th questions, addressing problem-solving ability.

The adapted version developed by the researcher was reviewed and approved by the first author in Arıkan and Erktin (2020) who had developed the original questions. After securing his approval, a mathematics teacher was asked to solve the questions (as suggested by the author himself) to eliminate any errors.

After these steps, the test was piloted with 60 5th and 6th grade students from three different public village schools in three different cities in Turkey, namely, Tekirdağ, Sakarya, and Tokat. These cities are chosen due to both convenience and purposeful sampling. The student profile in these schools were appropriate for the purpose of this research. Due to the covid-19 pandemic, the schools except in the villages had switched to distance learning. The researcher got in contact with the mathematics teachers at these schools, and they asked their students to do the ATPS test on paper. Then the teachers took photos of the papers they collected from the students and sent them to the researcher over email. Three of the participants were removed from the data because they decided to quit the test; therefore, 57 students' data was included in the pilot analysis.

According to Cicchetti (1994), the coefficient alpha which measures the internal consistency of a test needs to be at least .70 or over. The coefficient alpha of the pilot study is calculated by using SPSS 27 and it is measured as .796, which is referred to as acceptable.

3.4.3 Mathematics and ICT unit exams

The researcher prepared unit exams to assess the extent to which the students achieved the objectives of the Math and ICT lessons, as identified in the curricula for each unit. The exam questions were directly based on the objectives determined by the Ministry of National Education in the 5th grade curricula for Math and ICT. The Math test consisted of 20 multiple-choice questions, and the ICT test consisted of 10 multiple-choice questions. The same two tests were applied before and after the implementation as pre and post-tests.

3.4.4 Weekly assignments

At the end of each week, there was an assignment that consists of 2 or 3 mathematical questions sent through Google Forms. Answering the questions appropriately required understanding basic mathematical concepts. These tasks aimed to operationalize the mathematical reflection steps of the Arc of Learning method. A total of 5 mathematical reflection tasks were conducted throughout the implementation.

3.4.5 Students' artifacts

A total of 28 activities were carried out during the 5 weeks of implementation. the student artifacts created in of these activities were collected. 16 were the end product of group work, while 2 were individual work. In addition to collecting at least one ICT activity each time for the first three weeks, at least one math activity was collected each week throughout the entire process. Table 3 below shows which of the collected activities were group works. The artifacts were mostly gathered by students taking pictures of their own screens or taking pictures of their notebooks and sending them to the teacher over WhatsApp. In some of the activities, the artifacts/ students' answers were gathered on Google drive; for instance, when the students used the online drawing tool, i.e. Google drawings.

Table 3. Group Work During the Math & ICT Classes

Week	Lesson	Activity name	Group or individual work?
1	ICT	Route of the Robot	group
		Flowchart are entangled	group
		What is the name of that polygon?	group
	Math	Which one is a polygon?	group
		Tangram Algorithm	group
		Mystery of Diagonals-Part1	group
		Mystery of Diagonals	both
2	ICT	Tangram	group
	Math	Angles of the clock	group
3	ICT	The cups	group
		Creating Polygons	group
	Math	The quadrilateral family	group
4	Math	Triple Triangles	group
		From triangles to quadrilaterals	group
		The wooden frame	group
5	ICT	Distances in the maze	individual
	Math	Race in the school background	group
		The wooden frame- Cont.	group

3.5 Data collection procedures

Before the data collection process, first, the ethics committee's approval for research was obtained from Boğaziçi University. Then permission was secured from the Aksaray-Güzelyurt District National Education Directorate to carry out the survey, tests, and the implementation. Then the students and their parents were informed, and consent forms were sent to parents before the implementation. In Figure 2 the data collection procedures are summarized.

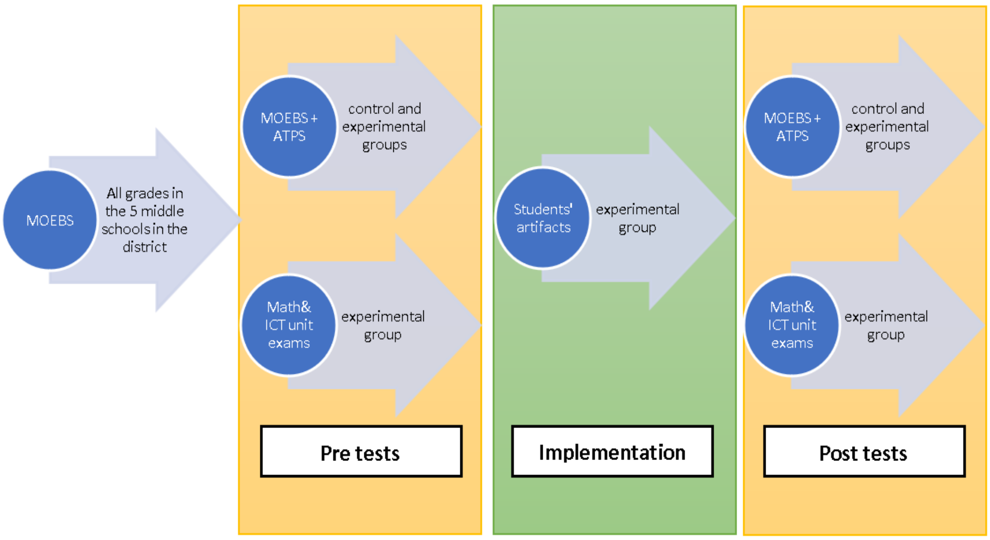


Fig. 2 Data Collection Process

Before the implementation, the Mathematics Oriented Epistemological Belief Scale (MOEBS) was carried out at all grade levels, except special education classes, in 5 middle schools in the district where the researcher works as a teacher. Three of these 5 schools are village schools and the other two are schools located in the city center. The school where the implementation was conducted is also located in the city center.

The experimental and control groups also took the ATPS test and the mathematics and ICT unit exams as the pre-test, in addition to MOEBS. These instruments, i.e. MOEBS, ATPS, and unit exams, were used as post-tests at the end of the study for the same students in the 5th and 6th grades. Through the implementation process, students were expected to answer the questions of mathematical reflection at the end of each week, which was collected by sending 2 or 3 questions in Google Forms about the mathematics objective of that specific week. The experimental group also responded to a feedback questionnaire to comment on the implementation at the end.

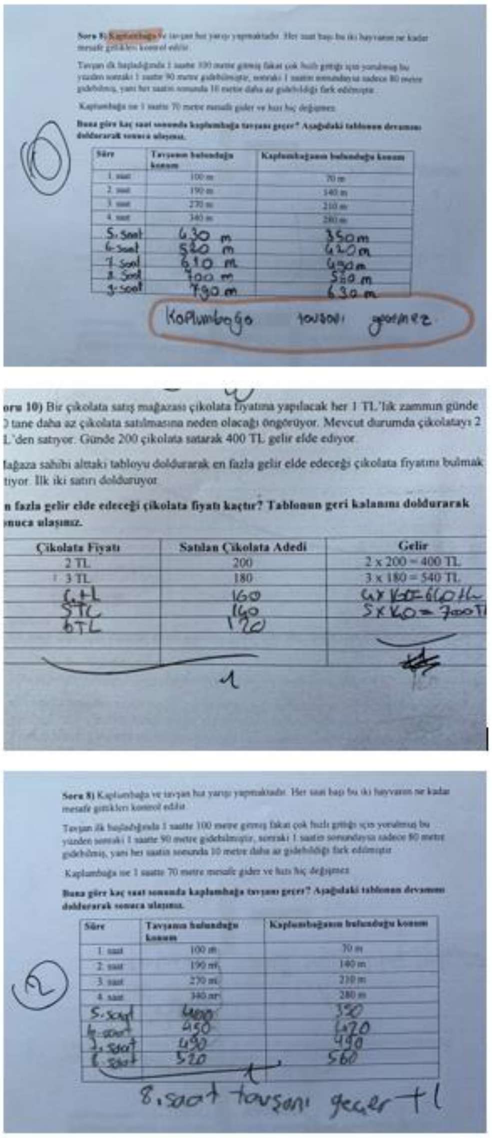
To understand the participants' learning progress, weekly assignments and student artifacts were collected during the implementation. Through the process students were expected to fulfill the required basic mathematical concepts, therefore the weekly assignments were given at the end of each week through Google Forms. Student artifacts were collected throughout the process from the students who attended classes conducted via video-conferencing online.

3.6 Data coding and scoring

There was one qualitative data instrument which was students' artifacts during the implementation and four different types of quantitative data instruments, MOEBS, ATPS, unit exams, and the weekly assignments. All the quantitative data were entered into the IBM SPSS 27 statistical analysis program to conduct the statistical tests.

The data collected via the MOEBS was scored as instructed by İlhan and Çetin (2013), described in the previous section. The highest total score that can be obtained from this scale was 135.

The scoring of the ATPS test was also based on the recommendation of the researchers who developed the original version. Each answer was scored over 3, with partial points possible for a partial answer: 0 points for no answer, and no evidence for correct process; 1 point for a partially correct answer (i.e. one or more steps correct, but not the final product), and 2 points for the correct steps and correct answer. A sample for each type of scoring is provided in Figure 3.



A sample for zero point

A sample for one point

A sample for two points

Fig. 3 Scoring of ATPS questions

3.6.3 Mathematics and ICT unit exams

The mathematics unit exam had 20 and the ICT unit exams had 10 multiple-choice questions. Both tests were evaluated with the same scoring strategy, 1 point for correct answers and 0 points for incorrect or blank answers. Thus, while the minimum score that a student can have is 0 for both tests, the maximum score is 20 for the math test and 10 for the ICT test.

3.6.4 Weekly assignments

The assignments sent through Google Forms at the end of each week included multiple-choice, open-ended, and matching questions. Each weeks' assignment had two or three questions and in total 13 questions for 5 weeks. Each open-ended question was worth 3 points: 0 points for no answer or incorrect answer, 1 point for a partially correct answer, and 2 points for a correct answer In the multiple-choice questions, as in the open-ended questions, 0 points were given to the incorrect or no answers and 2 points were given to the correct answers. For the first and second weeks, students could get a maximum of 4 points and for the rest of the weeks, they could get a maximum of 6 points. To compare the results of the first two weeks with the results of the following weeks, the scores of the first two weeks were proportioned to 6.

3.6.5 Students' artifacts

The artifacts were scored according to the requirements of that specific activity in the lesson plan. Each activity was scored out of ten points. While some of the activities were prepared to fulfill the Math objectives and some were for ICT objectives, each week at least one of the activities was created to assess both Math and ICT objectives. The activities were scored according to the predetermined requirements for each activity and the parts in that activity had points for correct answers. In some activities that included both Math and ICT learning objectives, scoring was made for the objectives of each course, as a student who scored high points for Math might score lower in ICT, or vice versa. In Figure 4, an activity from the third week is given as an example only for Math and Figure 5 represents an activity for both Math and ICT objectives.

A total of 201 artifacts were collected throughout the 5 weeks of implementation, and 98 of them were evaluated, 53 of them for all participants and the rest for selected students, according to the scoring rubrics that were prepared during the instructional design phase. Each activity was divided into small parts that serve the purpose of that activity and each was worth 10 points. If an activity was designed to meet the objectives of both Math and ICT curricula, then the activity was scored out of 20 points, 10 points for each topic covered in the activity.

Appendix M presents the evaluation of the twenty-three 5th graders' artifacts. A total of 5 activities were selected for analysis, one from each week that covered the objectives of both Math and ICT lessons.

The ratios of all students in the experimental group may not allow us to make the right inferences because these inferences were made by looking at the scoring of only one activity's product. For this reason, examining all activities and finding the average weekly score will enable us to obtain more accurate results; yet, since it would be difficult to evaluate all products for each student, some students were selected, and these evaluations were made for all the gathered products for each of these students.

Also, an interrater reliability analysis was conducted by using the Kappa statistic to determine consistency among two raters and the researcher. The first rater had 12 different artifacts and scored these artifacts by evaluating for both mathematics and ICT objectives, so she had 24 scores; and the other evaluated 16 for only mathematics objectives, so 16 scores were given. The interrater reliability for the first rater and researcher was found to be Kappa = .90 (p =.000) which is a perfect agreement whereas for the second rater and researcher was found to be Kappa

= .78 (p =.000) which is a substantial agreement according to the Kappa value interpretation by Landis and Koch (1977).

The Quadrilateral Family

We know that there are many quadrilaterals, and we call them square, rectangle, parallelogram. But where do these nomenclatures come from? According to what characteristics are these names given? Use the link https://www.geogebra.org/m/sWU3h2Jb to determine the common and distinct properties of the quadrilaterals. **(2 points)**

Please mark the appropriate places in the table below by using the following link https://forms.gle/hhQDQ97FNmNCTU7s9. **(5 points)**

	One pair of sides is equal	Two pairs of sides are equal	All sides are equal	One pair of sides is parallel	Two pairs of sides are parallel
Square					
Rectangle					
Parallelogram					
Rhombus					
Trapezoid					

Show the quadrilateral family tree in the link below according to the table above. **(3 points)**

https://padlet.com/dilekturan44/grjqrtx5zo9seyr8

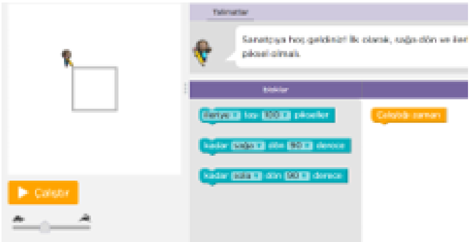
Fig. 4 Sample Math activity and its scoring

For the first part of "the Quadrilateral Family" activity one point was given for correct answers for both common and distinct properties; for the table, if student had marked at least two correct characteristics for each quadrilateral then she was given 1 point for each one. Lastly, each step created in the link given in the last part of the activity was scored as 1 point.

Code.org Quadrilateral Design (30 min)

Scoring: Math (out of 10p) = creating square 5p; creating rectangle 5p. ICT (out of 10p) = writing the algorithm correctly 5p; using the block-based program 5p)

The course at https://studio.code.org/s/artist/lessons/1/levels/1 will be used for the activity. Students get to know the page because they did various activities on the code.org web page in the previous ICT course. If the page is to be used for the first time, the teacher first introduces the block-based coding page. The following activity sheet is sent to students, students work individually



Students complete the square and rhombus in the first and second stages, while the teacher supports the students who need help. When all students complete this task, the teacher shares her screen and demonstrates these two steps in terms of side lengths and angles. Finally, the teacher shows the students that if the blocks did not exist, the algorithm for creating a square could be written as follows.

- start
- Forward 100 pixels
- Turn right 90 degrees
- Forward 100 pixels
- Turn right 90 degrees
- Forward 100 pixels
- Turn right 90 degrees
- Go forward 100 pixels
- Finish it

Then, the students are divided into groups of 2 and asked to create a rectangle what kind of algorithm they would need if we did not have a block-based application.

Fig. 5 Sample Math and ICT integrated activity and its scoring

The points for the correct algorithms and results in mathematics and ICT were specified in the figure 5; in detail, for the algorithm scoring, which was 5 points in total, using the phrases “start” and “finish”, using the right command such as “turn” and “go forward”, and creating the shape in minimum number of steps were scored as 1 point. For the mathematics scoring, if at the end student created a square she had 5 points, if she could not make a square then no points were given.

3.7 Data analysis

The first research question about the correlation between grade level and mathematics oriented epistemological beliefs in 5^{th} – 8^{th} graders was answered through descriptive statistics. First, the normality assumption was checked for the MOEBS scores by applying the Kolmogorov-Smirnov normality test, because the sample size was larger than 50. Although the MOEBS scores were normally distributed, since the other variable which was grade level is ordinal the Spearman's rho test was conducted in order to determine whether there is a correlation between the grade levels and the levels of mathematical epistemological beliefs.

The second research question about the 5^{th} graders' mathematics oriented epistemological beliefs after participation in a remotely delivered PBL integrating Math and ICT instruction was analyzed by conducting a paired-samples t-test. For comparison to a control group, independent samples t-test.

To answer the next set of research questions about the whether the online implementation correlate with the 5^{th} graders' algorithmic thinking and problem-solving skills, paired sample t-tests and independent sample t-tests were conducted, since the Shapiro-Wilk normality test showed that both the pre and post-test ATPS scores were normally distributed. Lastly, Wilcoxon Signed Ranks test was carried out for the Math and ICT unit exam scores, where a nonparametric test was appropriate.

Finally, for the fourth research question about the learning process, the student artifacts were scored based on an assessment rubric developed by the researcher based on learning objectives of each course. Thus, the student work was quantified and compared to determine whether there was any improvement over the five weeks.

CHAPTER 4

FINDINGS

In this chapter, the findings are presented in the order of the research questions listed at the end of the literature review section. The epistemological beliefs of middle school students are summarized through descriptive statistics; parametric statistical test results are presented to infer the differences in the algorithmic thinking and problem-solving (ATPS) abilities before and after the implementation of integrated PBL for Math and ICT, and to interpret whether there is a difference between the experimental and control groups. Mathematics and ICT unit exams were also investigated for 5th graders, and lastly, the learning process through the intervention is explored in student artifacts.

4.1 Mathematics related epistemological beliefs of middle school students

Research question 1: “Is there a correlation between grade level and mathematics oriented epistemological beliefs in 5th – 8th graders in a small school district in a rural province of Turkey?

In order to find out about the middle school students’ (from 5th grade to 8th grade) mathematics-related epistemological beliefs, first the Kolmogorov-Smirnov normality test was carried out to test for normal distribution, since the sample size was larger than 50. According to the result of the Kolmogorov-Smirnov test, the MOEBS scores of 5th and 6th grade students were normally distributed (*$p>0.05$*); however, 7th and 8th graders were slightly less than the .05 level (see table 4). The skewness was found -.699 (SE .162) and the kurtosis value was .648 (SE .322) for the data. In terms of the grade level, the skewness of the data from 5th, 6th, 7th, and 8th-grade levels were, respectively: -.193 (SE .297), -.130 (SE .383), -.150 (SE .327), and -.250 (.388). Orcan (2020) argued that there is a lack of consensus about the values of skewness to interpret normality, some suggest less than the absolute value of 1, some others propose less than the absolute value of 1.5, and some defend 3. According to all these suggestions, the result of the 7th and 8th graders' MOEBS scores can be taken as normally distributed in terms of their skewness value.

Table 4. Tests of Normality

	Kolmogorov-Smirnov[a]		
	Statistic	df	Sig.
5	.092	65	.200*
6	.096	38	.200*
7	.122	53	.048
8	.145	37	.047

The reliability and validity coefficients are acceptable in terms of all three factors in the test according to the authors who created the scale (Ilhan & Cetin, 2013). However, the test was originally developed for high school students; reliability statistics for the scale were also examined to check whether it is reliable for middle school students. The data collected from the 5 middle schools in the district, with a sample size of 227 was calculated as .737. Therefore, it is fairly reliable even at the middle school level.

The reliability of the 5th and 6th graders for the district data was explored separately, since the 5th and 6th graders in the researcher's school were the experimental and control groups. The Cronbach coefficient alpha reliability of the test for the 5th graders is .706 and for the 6th graders .759 (see table 5).

Table 5. Cronbach's Alpha for MOEBS

	Cronbach's alpha	N of items
all	.737	27
5th grade	.706	27
6th grade	.759	27

4.1.1 MOEBS descriptive statistics

In table 6, the descriptive statistics are presented for the MOEBS scores of the middle school students in the district. The score of the total MOEBS for this sample was between 27 and 135; BLDE was between 10 and 50, BLDT was between 10 and 50, and BTOOT was between 7 and 35. Also, according to the researchers who developed MOEBS, while lower BLDT and BTOOT scores mean more sophistication in epistemological beliefs, lower BLDE means less sophistication. To create a "total MOEBS" score the BLDT and BTOOT scores are reverse coded; therefore, in all three factors and in the total MOEBS, as the number increases the sophistication increase as well.

Table 6. Descriptive Statistics for MOEBS

		N	Mean	SD
	All	193	91. 10	12.11
	5th	65	90.26	9.86
TotalMOEBS	6th	38	90.76	10.25
	7th	53	92.32	9.47
	8th	37	91.14	10.68
	All	193	35.4456	7.76615
	5th	65	35.9231	7.257125
BLDE	6th	38	34.6316	6.976490
	7th	53	36.1887	6.400290
	8th	37	34.3784	7.432479
	All	193	33.2124	6.22044
	5th	65	32.6000	6.181626
BLDT	6th	38	33.2631	5.578357
	7th	53	33.3962	6.149858
	8th	37	33.9730	5.408258
	All	193	22.4352	3.40898
	5th	65	21.7385	3.501236
BTOOT	6th	38	22.8684	3.313943
	7th	53	22.7359	2.843014
	8th	37	22.7838	3.128144
	Valid N (listwise)	193		

In Table 6, the descriptive statistics of the students in the district are shown in detail according to their grade level and the factors of the MOEBS scale. The histograms of MOEBS scores for each grade in the district are given in the figure 6 below.

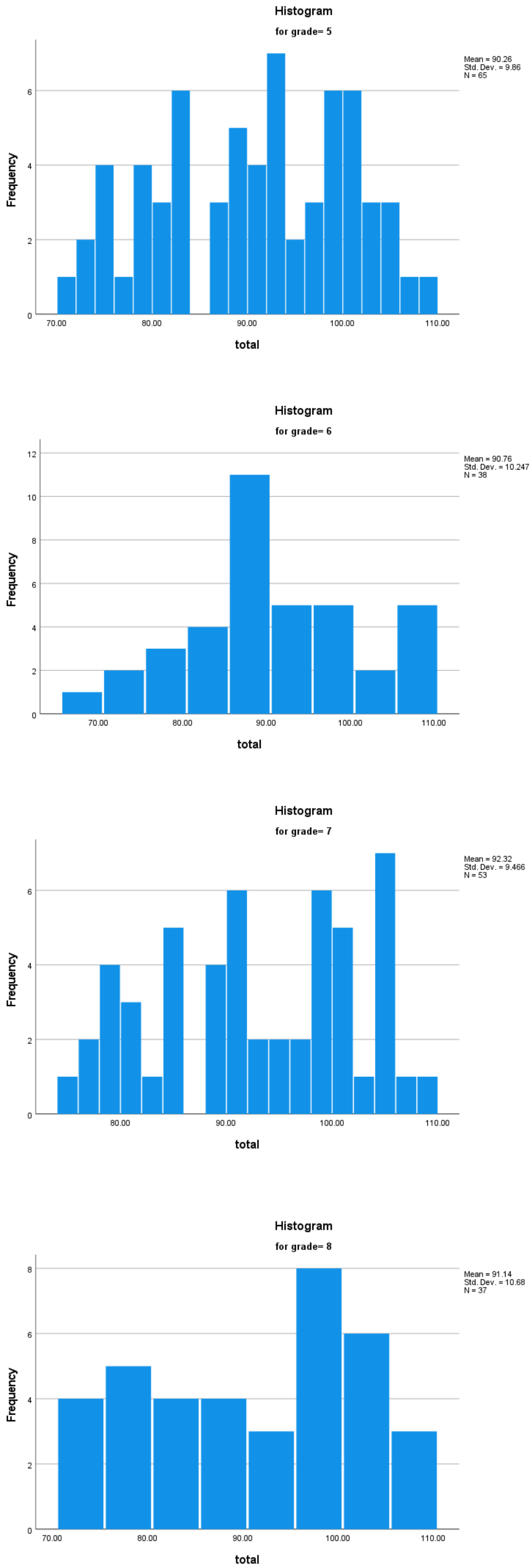


Fig. 6 Histograms of MOEBS scores for each grade

4.1.2 MOEBS scores and grade level relation

A scatterplot graph was formed from the students' mathematics oriented epistemological beliefs scores at 4 different grade levels to see whether there was an association between these two variables. As shown in Figure 7, the scatterplot graph. did not indicate a significant relation between the grade level and MOEBS scores.

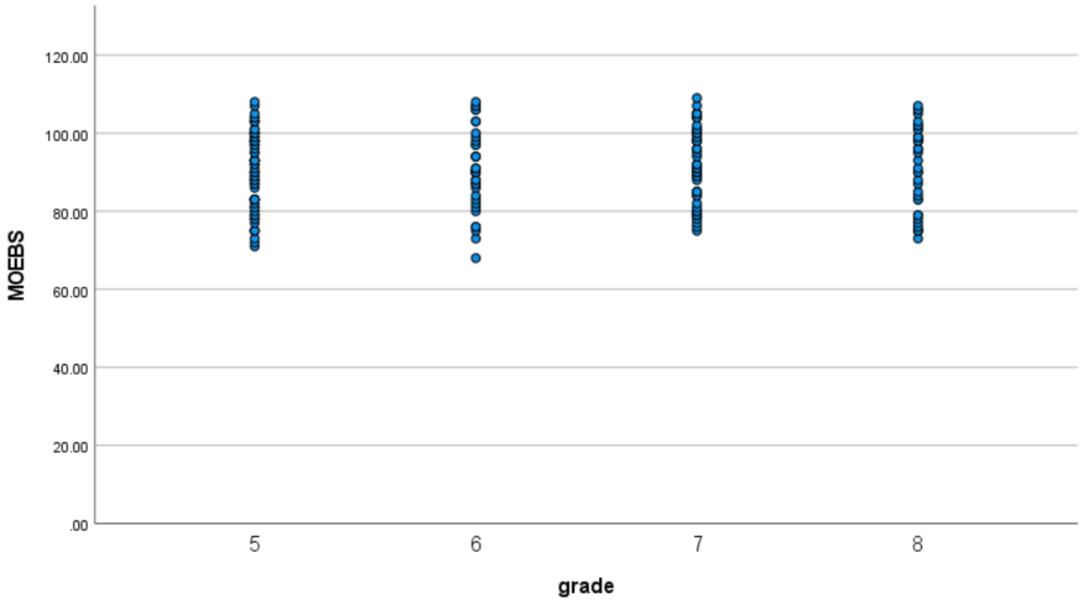


Fig. 7 The scatterplot of MOEBS by grade level

MOEBS data was collected from the students who were in 5th, 6th, 7th, and 8th grade levels. Since one of the variables, grade level, is ordinal, Spearman's rho was calculated to check the association between MOEBS and grade level. There was no significant correlation between the two variables, r (191) = .06 with a corresponding p-value of 0.407. The Spearman correlation coefficient supported the result from the scatterplot graph. Descriptive statistics and correlation rank is represented in table 7.

Table 7. Spearman's rho Coefficient Between Grade Level and MOEBS

	Descriptives		Correlation
	M	SD	
Grade	6.32	1.13	0.06
MOEBS	91.09	9.95	

The MOEBS scores from the 5th and 6th graders in the district were also compared to see whether there was any significant difference in MOEBS between these two grade levels, since the 6th graders would function as the control group in the research school from the same school district. No significant difference was found between 5th grade students' MOEBS scores (M = 90.26, SD = 9.86) and 6th grade students (M = 90.76, SD = 10.25), $t(101) = .246$ and p =.807. (See table 6) at the district level. Then the mean of the 5th graders scores in the experimental group were compared to that of the 6th graders in the control group MOEBS scores were compared. An independent sample t-test comparing the pre-test means revealed a significant difference between the experimental (M = 89.30, SD = 14.42) and the control (M = 96.94, SD = 9.17), $t(39) = 2.023$ and p = .05. The descriptive statistics for experimental and control group is given in table 8.

Table 8. Descriptive Statistics of MOEBS of 5th and 6th Graders' Pretest and Posttest

	5th grade						6th grade					
	PreTest			PostTest			PreTest			PostTest		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
TotalMOEBS	23	89.30	14.42	23	93.61	10.81	18	96.94	9.17	18	99.06	11.49
BLDE	23	36.61	8.35	23	38.13	7.55	18	38.33	5.55	18	39.61	5.37
BLDT	23	32.91	4.80	23	33.52	5.34	18	36.06	6.44	18	36.17	6.86
BTOOT	23	19.78	4.32	23	21.95	3.47	18	22.56	3.13	18	23.28	3.61
Valid N (listwise)	23			23			18			18		

4.1.3 MOEBS scores of 5^{th} and 6^{th} graders after the implementation

Research question 2: Is there a significant difference in 5^{th} graders' mathematics oriented epistemological beliefs compared to a control group after participation in a remotely delivered online implementation of a PBL based integrated Math and ICT instruction in a middle school in a rural school district?

The normality assumption was checked, and the data was normally distributed for 5^{th} and 6^{th} graders (see table 4). A paired sample t-test was conducted to compare 5th-grade students' MOEBS scores before and after the implementation of the Arc of Learning framework integrating mathematics and ICT and after that implementation. There was not a statistically significant difference in the 5^{th} graders scores for the pre-test ($M = 89.30$, $SD = 14.42$) or the post-test ($M = 93.61$, $SD = 10.81$) and $t(22) = -1.73$, $p = .097$ with a fairly medium effect size (Cohen's $d = 0.34$).

An independent sample t-test was conducted to compare the post-test MOEBS scores of the 5^{th} grade students in the experimental group to that of the 6^{th} graders, who served as the control. There was not a statistically significant difference in the scores for the experimental ($M = 93.61$, $SD = 10.81$) or the control groups ($M=99.06$, $SD = 11.49$); $t(39) = -1.33$, $p=.191$. Thus, after the intervention there was no significant difference between the 5^{th} graders and 6^{th} graders MOEBS scores with a medium effect size (Cohen's $d = 0.49$).

4.2 Integrated curriculum-based implementation and students' ATPS

Research question 3: In what ways and to what extent do the 5th graders' algorithmic thinking and problem-solving skills relate to the online implementation of the PBL-based integrated Math and ICT instruction? (3a): Is there a significant difference in

5th graders' algorithmic thinking and problem-solving skills at the end of the implementation based on a within groups comparison? (3b): Is there a statistically significant difference in 5th graders' algorithmic thinking and problem-solving skills when compared to a control group?

To answer these research questions, paired samples t-test and independent samples t-tests were applied. First the normality of the data from the Algorithmic thinking and problem-solving skills test was explored to see whether the assumptions of the t-test were met. The normality test was conducted for the experimental group (5th graders) and the control group (6th grades). Since the sample size is smaller than 50, the Shapiro-Wilk test was used, which indicated that the scores were normally distributed for both groups in both the pre-test and post-tests. A Cronbach alpha value between .70 and .79 is considered fair, while between .80 and .89 is considered good, and .90 and above excellent (Cichietti, 1994). Since the Cronbach's Alpha coefficient for the pre-test of the ATPS test was calculated as .826, this test can be considered reliable for this data. The Cronbach's Alpha coefficient for the post-test was calculated as .815, which means that the post test was also reliable (see table 9).

Table 9. Tests of Normality

		Shapiro-wilk		
		Statistic	df	Sig.
5th grade	Pre-test	.927	23	.094
	Post-test	.963	23	.524
6th grade	Pre-test	.940	22	.200
	Post-test	.938	22	.178

To analyze whether there was a statistically significant difference between pre-test and post-test scores within the experimental group, paired sample t-test was executed. A significant difference was found in the 5th graders' pre-test ATPS scores (M = 5.92, SD = 3.658) and their post-test scores (M = 8.21, SD = 4.191), t(23) = -4.382 and *p* = .000. On the other hand, for the 6th graders, there was no significant difference during the same time period between the pre-test (M = 8.09, SD = 5.847) and post-test (M = 8.27, SD = 5.849), t(21) = -.310 and *p* = .760 (see table 10). Looking closely, while the 5th graders significantly improved their scores with a medium effect size (Cohen's *d* = 0.58).

Table 10. Paired-sample T-test Statistics for ATPS Scores

		Paired Differences							
					95% Confidence Interval of the Difference				
		Mean	SD	S. Error Mean	Lower	Upper	t	df	Sig. (2-tailed)
5th Grade	Pre_ATPS - Post_ATPS	-2.29	2.56	0.52	-3.37	-1.21	-4.38	23	0.000
6th Grade	Pre_ATPS - Post_ATPS	-0.18	2.75	0.59	-1.40	1.04	-0.31	21	0.760

Further, an independent samples t-test was conducted to compare the pre- and post-test ATPS scores of the experimental and control groups'. There was no significant difference between the pre-test scores of the 5th graders in the experimental group (M = 5.92, SD = 3.658), and the 6th graders, who served as a control group, (M = 8.09, SD = 5.85); t(44) = -1.53, p = .134 with a medium effect size (Cohen's d = 0.45). There was no significant difference between the post-test scores for the 5th graders (M= 8.21, SD= 4.191) and 6th graders (M = 8.27, SD = 5.849); $t(44) = -.043$, p = .966 and the Cohen's d = 0.01.

4.3 Integrated curriculum relations with students' math and ICT unit exam scores

Research question 3c: Is there a statistically significant difference in 5th graders' mathematics and ICT unit exam scores after the intervention?

To compare the Math and ICT exam scores given at pre- and posttest, a paired samples t-test was carried out. First the Shapiro-Wilk test was carried out to test the normal distribution of the data. The test indicated that only the post-test of ICT scores was normally distributed (see table 11).

Table 11. Normality Tests

	Shapiro-Wilk		
	Statistic	df	Sig.
PreMath	0.902	23	0.028
PostMath	0.868	23	0.006
PreICT	0.867	23	0.006
PostICT	0.942	23	0.196

Three of the test scores were not normally distributed according to the normality test, however the reason behind that nonnormality could be the low amount of data. Therefore, the skewness of the data was investigated, too. The skewness of the mathematics pre-test was found .844 (SE .481) and the kurtosis value was 1.570 (SE .935); for mathematics, the post-test was 1.317 (SE .481) and the kurtosis was 1.274 (SE .935); of ICT pre-test was .540 (SE .481) and the kurtosis was -.974 (SE .935). Even though most researchers suggest the limit of normality as absolute value 1, Lei and Lomax (2005) claim that skewness of less than absolute value 1 is slight nonnormality and between the absolute value of 1 and 2.3 is moderate nonnormality. Nonetheless, the data was analyzed via a non-parametric test, Wilcoxon Signed Ranks test to answer research question (3c).

The Wilcoxon signed ranks test showed that the experimental groups' mathematics post-test scores (M = 7.70, SD = 3.913) were significantly higher than mathematics pre-test scores (M = 4.87, SD = 3.195), Z(22) = 3.40 and $p = .001$ with a large effect size (Cohen's $d = 0.79$). Also, there was a significant increase in the ranks for the ICT post-test scores (M = 4.13, SD = 1.714) compared to the ICT pre-test scores (M =2.78, SD = 1.731), Z(22) = 3.14 and $p = .002$, again, with a large effect size (Cohen's $d= 0.78$). Upon careful examination, the large effect sizes support that the implementation resulted a significant difference in participants' mathematics and ICT achievement.

4.4 Relations among MOEBS, ATPS, Mathematics and ICT achievement scores

A nonparametric correlation test, Spearman's rho, was applied to see whether there was a hint of correlated scores for epistemological beliefs, ATPS skills, and mathematics and ICT course achievement before and after the implementation.

A statistically significant positive correlation was found between ATPS and ICT scores, ATPS and mathematics scores, and mathematics and ICT scores for both pre-tests and post-tests. As seen in the tables 12 and 13, in the pre-test scores from the mathematics unit test was not statistically significantly correlated with the scores from the ICT unit test while in the post-test results mathematics and ICT scores were significantly correlated. Also, the algorithmic thinking and problem-solving skills were correlated with the ICT scores in both results. There is no statistically significant correlation between MOEBS and the other variables neither for pre-tests nor post-tests. However, these results should be taken with caution, since the sample size was small.

Table 12. The Correlation Among Pre-tests of Fifth-Graders

		Math	ICT	ATPS	MOEBS
Math	Coefficient	1	.396	.167	.192
	Sig. (2-tailed)		.062	.446	.379
	N	22	22	22	22
ICT	Coefficient	.396	1	.552**	.165
	Sig. (2-tailed)	.062		.006	.451
	N	22	22	22	22
ATPS	Coefficient	.167	. 552**	1	.065
	Sig. (2-tailed)	.446	.006		.768
	N	22	22	23	22
MOEBS	Coefficient	.192	.165	.065	1
	Sig. (2-tailed)	.379	.451	.768	
	N	22	22	22	23

**. Correlation is significant at the 0.01 level (2-tailed).

Table 13. The Correlation Among Post-Tests of Fifth-Graders

		Math	ICT	ATPS	MOEBS
Math	Pearson Correlation	1	.378*	.522*	.33
	Sig. (2-tailed)		.049	.011	.125
	N	23	22	22	23
ICT	Pearson Correlation	.378*	1	.439*	.057
	Sig. (2-tailed)	.049		.036	.795
	N	22	22	22	22
ATPS	Pearson Correlation	.522*	.439*	1	.038
	Sig. (2-tailed)	.011	.036		.864
	N	22	22	22	22
MOEBS	Pearson Correlation	.33	.057	.038	1
	Sig. (2-tailed)	.125	.795	.864	
	N	23	22	22	23

*. Correlation is significant at the 0.05 level (2-tailed).

4.5 Learning process

Firstly, the weekly assignments which were named as mathematical reflection in the Arc of Learning framework is examined for the experimental group. Table 14 below presents all of the students' weekly assignment scores, based on questions about the Math objective of the week, different objective each week. While all of the objectives up to the 4th week included geometric relations, metric conversions were targeted in the 5th week, and at the end of the application, it was expected that the students would be able to make conversions between different units in the perimeter calculations of different geometric shapes. The reason behind the decrease in the fifth week might be the difference in the objectives.

Table 14. Weekly Assignment Scores

	week 1	week 2	week 3	week 4	week 5
Zehra	3	0	6	6	4
Ali	0	0	0	4	2
Nida	0	0	2	2	3
Betül	0	0	0	6	0
Mehmet	0	0	0	6	3
Merve	4.5	6	2	4	5
Dila	4.5	6	3	4	5
Faruk	3	3	5	6	4
Melisa	3	6	5	6	6
Burak	0	1.5	0	6	3
Ayşe	3	6	4	6	6
Esin	1.5	6	2	4	2
Ekin	3	3	4	4	5
Rıza	0	0	0	0	0
Yusuf	1.5	4.5	3	6	2
Bahar	1.5	3	2	6	4
Eylül	0	0	0	0	0
Yasin	0	0	0	0	0
Ömer	0	0	0	0	0
Osman	0	0	0	0	5
Kerim	0	0	0	0	0
Hasan	4.5	6	5	6	5
Gökhan	0	0	2	2	2

Note. Each week's scores are calculated out of 6 points.

Although the questions in each weekly assignment was related to the objectives covered that week, the students increased their assignment scores gradually, over the period of the implementation. At the end of the 4th week, maximum values were obtained. In figure 8 the stacked line graph represents weekly assignment data showing the tendency of the scores through the process.

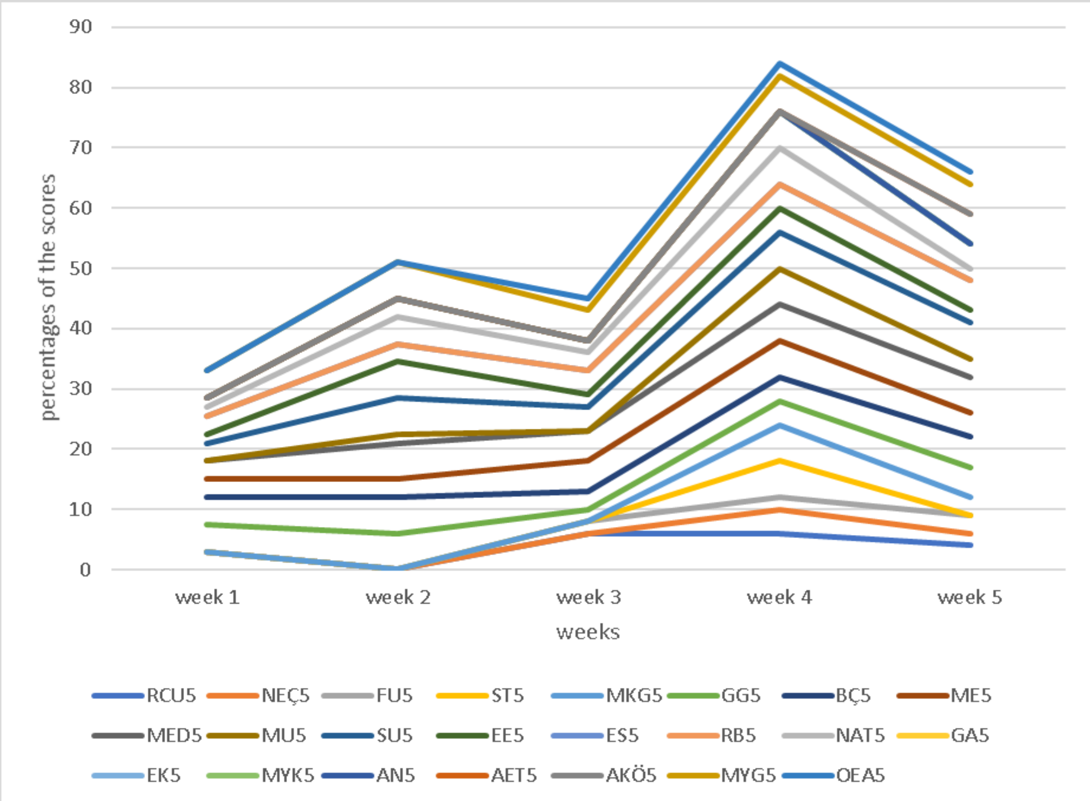


Fig. 8 Changes in the scores of end-of-the-week assignments for all participants

Table 15 and Table 16 show the weekly assignment results for the whole class, with one activity selected from each week in Mathematics and ICT classes, respectively. The results are presented in descending order based on the participants' ATPS scores.

Table 15. Student Scores for the Weekly in-class Math Assignments

	week 1	week 2	week 3	week 4	week 5
Zehra	10	4	10	8	10
Ali	5	0	5	3	5
Nida	4	4	5	6	5
Betül	0	4	5	6	7
Esin	6	4	5	6	5
Yusuf	10	3	5	6	6
Yasin	-	0	0	0	2
Ömer	-	3	5	6	6
Osman	0	0	-	-	6
Hasan	6	8	10	10	8
Mehmet	2	0	5	8	8
Merve	10	7	10	8	9
Ekin	5	5	5	8	6
Eylül	0	8	5	6	6
Rıza	0	-	5	3	6
Kerim	5	3	10	6	8
Ayşe	10	8	10	10	10
Bahar	5	7	10	8	8
Gökhan	0	4	10	8	8
Dila	10	7	8	8	8
Faruk	5	7	8	6	10
Melisa	10	8	10	10	10
Burak	5	7	10	10	9

N= 23

When the scores of the in-class Math assignments from the first week are compared to the scores from the last week, it can be seen that 15 out of 23 students increased their points, while 4 students' scores decreased and 4 students' stayed the same. Three of the 4 students who stayed the same was due to a ceiling effect, as these 3 students had already scored highest score in the first week.

Table 16. Student Scores for the Weekly in-class ICT Assignments

	week 1	week 2	week 3	week 4	week 5
Zehra	8	3	8	10	6
Ali	0	0	5	4	3
Nida	3	0	5	5	6
Betül	0	0	8	4	5
Esin	3	6	5	6	6
Yusuf	-	0	5	4	6
Yasin	-	0	0	0	3
Ömer	-	3	5	4	5
Osman	0	3	-	-	5
Hasan	3	6	8	8	8
Mehmet	3	0	5	6	5
Merve	6	8	8	6	8
Ekin	3	6	8	6	6
Eylül	3	3	5	6	6
Rıza	0	-	5	4	5
Kerim	3	3	5	4	6
Ayşe	8	8	10	10	8
Bahar	3	3	10	8	8
Gökhan	0	3	5	6	6
Dila	6	6	5	5	8
Faruk	3	6	10	6	8
Melisa	8	8	10	6	8
Burak	6	3	8	6	10

N= 23

When the ICT in-class assignment scores from week 1 and week 5 are compared, it can be seen that 20 out of 23 students improved their ICT scores; however, these increases were not regular and stable for each week. That is, even though these 15 students increased their first-week scores in the 5th week, 6 of them had achieved their maximum scores before the 5th week and they decreased their scores after the peak. Additionally, for 2 out of 23 students there was no change in scores, and 1 student's score decreased from the first to the last week.

The artifacts to be evaluated were selected based on the participants' ATPS scores to gain further insight about the students' learning progress. All twenty-two participants were grouped into 4 groups based on the degree of change they achieved in the post ATPS test: large increase, slight increase, no increase, decrease in the ATPS score (see table 17).

Table 17. Grouping According to the Difference Between Pre & Post ATPS Scores

	Participants	**Difference in ATPS**
Decrease	*Zehra	-3
	*Ali	-2
No change	*Nida	0
	*Betül	0
Slight increase in	*Esin	1
	Yusuf	1
	Yasin	1
	Ömer	1
	Osman	1
	Hasan	1
	Mehmet	2
	*Merve	2
	Ekin	2
	Eylül	2
	Rıza	3
	Kerim	3
Large increase	*Ayşe	4
	Bahar	4
	Gökhan	4
	Dila	5
	*Faruk	6
	*Melisa	6
	*Burak	8

*Note*Participants selected to examine in detail.*

Two participants from each group were selected randomly for further study of their artifacts. Two more participants, Ayşe and Faruk, were also selected for further examination, as they were of interest to the researcher because Ayşe was already a high achiever at the beginning of the implementation and scored a very high ATPS score on the pre-test, and Faruk scored lower on the Math unit exam at post-test. Thus, a total of 67 artifacts from 10 students were examined to investigate the improvement of the learning process. The final scores were calculated by taking the averages of Math and ICT points for each week.

In addition to the artifacts, the 10 students' responses to mathematical reflection questions which they responded at the end of each week were also examined. The Appendix N represents the scores for all 13 questions for five weeks, and a weekly score for each participant calculated out of 6 points.

Table 18 and Table 19 below represent the averages of each week's product scores for both Math and ICT curriculum for the selected 10 students.

Table 18. Mathematics Scores of the Collected Products from Selected Students

Change in ATPS score		week1	week2	week3	week4	week5
Decrease	**Zehra**	8.0	9.0	8.5	8.5	8.7
	Ali	2.0	1.7	3.5	2.3	5.0
No change	**Nida**	4.3	3.7	4.5	5.0	5.0
	Betül	2.0	3.0	4.5	5.0	7.0
Slight increase	**Merve**	8.7	7.3	9.0	8.3	8.3
	Esin	5.7	7.0	5.5	6.8	7.3
High increase	**Faruk**	7.3	7.0	6.5	6.0	9.3
	Melisa	9.3	8.7	8.5	9.2	9.3
	Burak	5.7	8.7	8.0	10.0	9.7
	Ayşe	9.3	10.0	9.5	10.0	10.0

Note. The scores of each week is the average of all the collected products of that week.

When the Math scores of the artifacts for selected students from the first week are compared to the last week, 7 out of 10 increased their scores, while 2 students kept their scores the same, and only one student (Merve) had a slightly decrease regardless of their ATP score category. The 2 students who had no change and the one who decreased their points had already scored top scores (8.7, 9.3 and 8.7 out of 10).

Table 19. ICT Scores of the Collected Products From the Specific Students

Change in ATPS score		**week1**	**week2**	**week3**	**week4**	**week5**
Decrease	**Zehra**	6.3	3	9.0	9.0	6
	Ali	0.3	0	5.5	4.0	3
No change	**Nida**	3.7	0	6.0	4.5	6
	Betül	2.7	0	7.0	4.0	5
Slight increase	**Merve**	5.7	8	9.0	8.0	8
	Esin	5.7	6	6.0	7.0	8
High increase	**Faruk**	4.3	6	8.5	6.0	8
	Melisa	9.0	8	10.0	8.0	8
	Burak	4.0	3	7.5	7.0	10
	Ayşe	9.3	8	10.0	10.0	8

Note. The score of each week is the average of all the collected products of that week

As for the ICT scores, all 10 scores, except one, increased until the 4th week. In the 5th week, 3 students' scores decreased, and 3 others remained the same.

Table 20. All Data Except the Weekly Assignments Collected from the Selected Students

	mathematics					ICT					math unit exam		ICT unit exam		ATPS		MOEBS	
	week1	week2	week3	week4	week5	week1	week2	week3	week4	week5	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test
Zehra	8.0	9.0	8.5	8.5	8.7	6.3	3.0	9.0	9.0	6.0	12	16	6	8	14	11	108	91
Ali	2.0	1.7	3.5	2.3	5.0	0.3	0.0	5.5	4.0	3.0	7	9	2	4	2	0	103	95
Nida	4.3	3.7	4.5	5.0	5.0	3.7	0.0	6.0	4.5	6.0	7	7	5	4	10	10	73	92
Betül	2.0	3.0	4.5	5.0	7.0	2.7	0.0	7.0	4.0	5.0	4	6	3	4	4	4	103	113
Merve	8.7	7.3	9.0	8.3	8.3	5.7	8.0	9.0	8.0	8.0	5	13	5	6	6	8	100	98
Esin	5.7	7.0	5.5	6.8	7.3	5.7	6	6.0	7.0	8	5	6	1	4	3	4	99	99
Faruk	7.3	7.0	6.5	6.0	9.3	4.3	6.0	8.5	6.0	8.0	6	4	1	3	4	10	92	82
Melisa	9.3	8.7	8.5	9.2	9.3	9.0	8.0	10.0	8.0	8.0	7	18	6	6	6	12	100	92
Burak	5.7	8.7	8.0	10.0	9.7	4.0	3.0	7.5	7.0	10.0	3	11	1	2	3	11	73	90
Ayşe	9.3	10.0	9.5	10.0	10.0	9.3	8.0	10.0	10.0	8.0	13	12	3	6	14	18	103	121

It was observed that the students who increased their ATPS score were able to use the information given to them correctly while solving problems and were able to solve the given problem step by step. Nine out of 13 students who increased their ATPS score by at least two points knew that when converting between units of length, they should be multiplied and divided by 10. Six of these nine students used this information in the problem they needed to transform. On the other hand, seven out of 10 students who did not increase their ATPS score or increased only 1 point also knew that it should be multiplied by 10 when transforming, but only one of these seven was able to solve the problem exactly.

4.5.1 Review of selected students' weekly assignment and in-class artifacts

Since all the students of the experimental group could not be examined in detail, 10 participants were selected and the activities of these participants in the lesson were evaluated by scoring them according to their mathematics and ICT achievements, and the weekly assessments (mathematical reflection) scores at the end of each week were given quantitively. In this section, the answers given by the selected students in the weekly assessments and their contributions to the artifacts in the in-class activities were explained student by student. These students were ordered in terms of their ATPS increases from the smallest to the largest value.

Zehra: In her weekly assignments, Zehra usually gave correct answers, and made only minor mistakes. For example, in the 2nd week's question of classifying triangles according to their angles and sides, she confused the places of the triangle types, that is, she wrote triangles according to their angles (acute, right-angled, and obtuse triangles) in the question of triangles according to their sides and vice versa, even though in the Turkish naming of triangles, the words angle and side are also written directly in the name of the triangle. Another mistake was that in the metric conversion question in week 5, she multiplied and divided by 10 and got the conversion correct, but in the following multiple-choice question "36 meters length is not equivalent to which of the following?" she did not select the correct answer, but the first choice in the list. Although she was good at the assignments and was better on the tasks that requires content knowledge, she sometimes had difficulties in mathematical understanding. For instance, while finding the diagonals of polygons, the students were asked to draw diagonals of hexagon on GeoGebra, she tried to draw diagonal on triangle too, and when she presented her work even though her friends said that it was not drawn from corner to corner, she said that a diagonal was needed because all polygons have one and it is the only way (see figure 9).

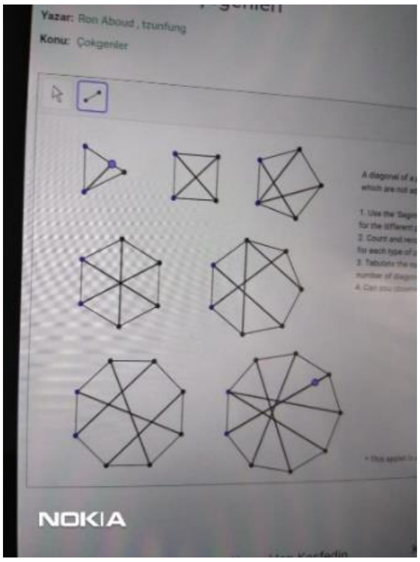


Fig. 9 Diagonals of Polygon

Ali: In the first week, Ali got all the answers wrong, and in the second week, he only wrote his name and sent the assignment without answering the questions. Even the multiple-choice question about the appropriate visual in week 3 was wrong, though answered correctly by 70 percent of the participants. The following week, the questions about interior angles were answered correctly, he correctly marked the sum of the interior angles of triangles and quadrilaterals, but he did not express his opinion about why all quadrilaterals and triangles have the same interior angles in total. His attitude towards the weekly assignments shed light on his approach to lessons in general. It seems that Ali did not follow the lessons very carefully and did not participate actively in group work.

Nida: Nida sent out the form with no answers in the first and the second weeks. The following week, she chose the right answer among the given visuals in the question about parallel sides; however, the rest of the questions were wrong. In the fourth week, while she wrote that quadrilaterals have 360 degrees of interior angles, she did not give the right answer to the interiors of triangles, nor did she express her thoughts about whether the interior angles would always be the same. In the fifth week, even though Nida knows what she needs to do to convert metric units because she answered correctly the question of “What operation do you do when converting between metric units of length?”; yet she could not make the correct conversion in the next questions.

Betül: In the first week she did not give any answers, and the second week she only wrote her name with no answers to the questions. The following week, she provided no correct answers, even for the question visualization question. In the fourth week, Betül chose the correct answers about the interior angles of triangles and quadrilaterals; and, she indicated that all quadrilaterals and triangles have the same interior angles. She gave no answers about the metric conversion at the end of the last week.

Merve: While at the end of the two weeks Merve correctly answered the questions, during the “tangram algorithm” activity, she correctly said "I made a square" as an explanation of what she had created for the square she had drawn, but for the other polygon (see figure 10) she said "it's not about math, I made a tree". The third week she had a misunderstanding about the basic concepts of quadrilaterals such as sides and diagonals. When asked about which quadrilaterals have equal “diagonals” she responded square and rhombus. It might be a problem about the quadrilaterals because even with the group work during the lessons they could not have the correct answers. Next week, the week they learned the sum of the angles of triangles and quadrilaterals, she answered that triangles have 180 degrees, and quadrilaterals have 360 degrees in total, yet she claimed that all triangles may not have the same sum of the interior angles because there are different types of triangles.

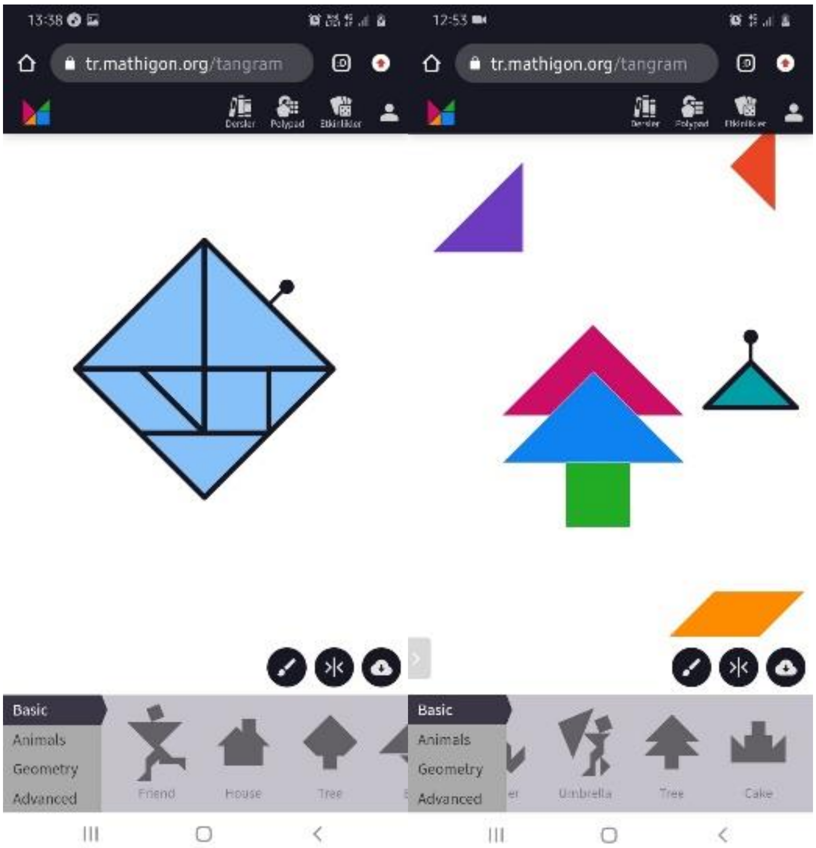


Fig. 10 Student artifacts about the “Tangram Polygon”

Esin: In the first week, Esin only answered the question about the conditions of being a polygon and only mentioned being a closed shape. In the second week, she answered the questions about the triangle classification and named it correctly. The following week, although she did not give the correct answer to the question about the diagonals, she gave the correct answer to the question about the side lengths. In the 4th week, she knows that the sum of the interior angles of the triangle is 180 degreesand the interior angles of quadrilaterals is 360 degrees; yet, she said that this sum could change for different quadrilaterals. Last week, Esin knew she had to multiply by 10 while doing a metric conversion, but she could not solve the problem.

As for the interior angles of the quadrilaterals in the 4th week, a close examination of the "code.org quadrilateral design" artifact showed that Esin made 360-degree quadrilaterals by making four 90-degree turns (see Fig. 11). However, the fact that she did not do any activity related to the interior angles of a quadrilateral other than a square and a rectangle during the lesson may have made her think that the interior angles of different quadrilaterals may differ.

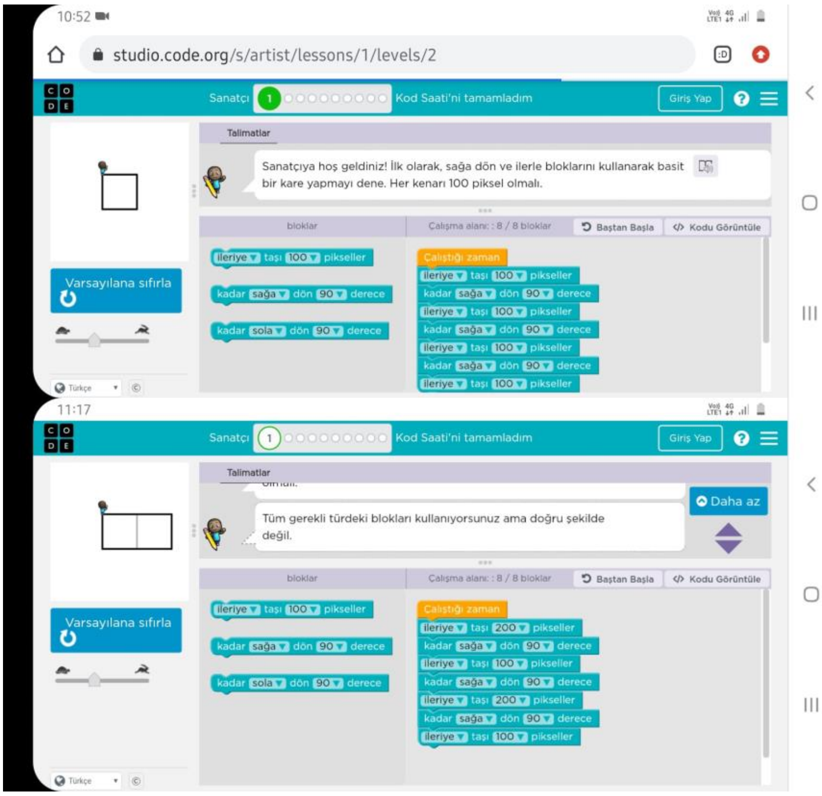


Fig. 11 Student’s artifacts about the “Quadrilateral Design”

Dila: Although Dila's answers to the weekly assignments were generally correct, she stated that she was undecided about whether the sum of the interior angles of all quadrilaterals and all triangles were the same when asked in the 4th-week. She did state that the sum of the interior angles of quadrilaterals and triangles is 360 and 180 degrees, however, as in Merve's case, no induction was made.

In the "Flowchart are entangled" activity, Dila and her groupmates Kerim and Nida named the parts of the flowchart as the 1st shape, the 2nd shape, and so on, instead of ellipse or rectangle, since they did not seem to know the names of the shapes of flowchart. Dila started to share her screen and she did what her groupmates told her to, but the voices got mixed up while describing the shapes as the 1st shape 2nd shape, and counting each shape one by one became confusing, so instead of saying it, her groupmates started to draw on the screen which was shared by their group mate. This instance can be an example of how students adapt quickly to the situation and try to solve the problems they encounter, even though there are such problems in group work in remote instruction.

Faruk: In the evaluation of the first week, Faruk was able to answer the question of how we decide whether the shapes are polygons or not, according to the joining of their sides. Although it is not clear whether it means a straight or curved shape or a closed shape, it can be deduced that he was not very knowledgeable about the information covered in the 1st week's lessons. He answered the question of the basic elements of polygons (having only sides), that is, he interpreted them according to what he sees first. He wrote only one category for the triangle classification questions in the 2nd week. For example, he wrote only equilateral triangles for triangles based on their sides, and only right angles for triangles based on their angles. In the third week, in the questions about the quadrilateral family, he answered correctly both the questions in which the shape was presented visually, and its direct properties were given without adding visuals. This development may indicate an improved understanding of polygons. He answered correctly answered the interior angles and metric conversion questions of the 4th and 5th weeks.

Melisa: In all of the weekly assignments, Melisa gave correct answers, except in week 1, when she made a small mistake about the conditions for a shape to be defined as a polygon. At the end of the whole class discussion in the first week's lesson, it was concluded that at least 3 sides are needed for a geometrical shape to be a polygon, and this feature was shared when the whole class was gathered after the discussion. Still, Melisa replied that it must consist of at least one edge

In the "What's the name of the polygon?" activity, students were divided into groups and started to organize the naming algorithm. After looking briefly at the parts in the file, Melisa said to her groupmates (Esin and Zehra): "We must first make sure it is a polygon, then we can name it by looking at the number of vertices." The work of this group can be seen in figure 12. Students seem to have learned that if the given figure does not consist of line segments, it is not a polygon, if it does, they know that it is a polygon, so they can move on to the naming stage, but they do not know how to show it in the flow chart. The correct flowchart samples are represented in figure 13.

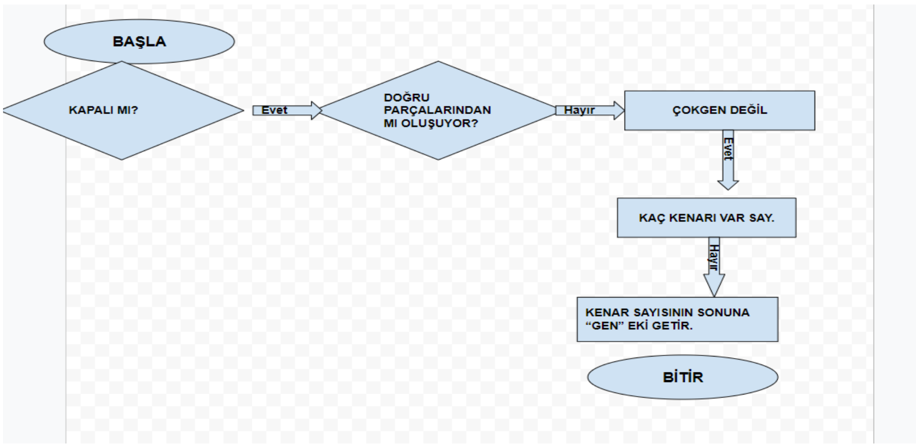


Fig. 12 Flowchart created by Melisa, Esin, and Zehra for the activity "What's the name of the polygon?"

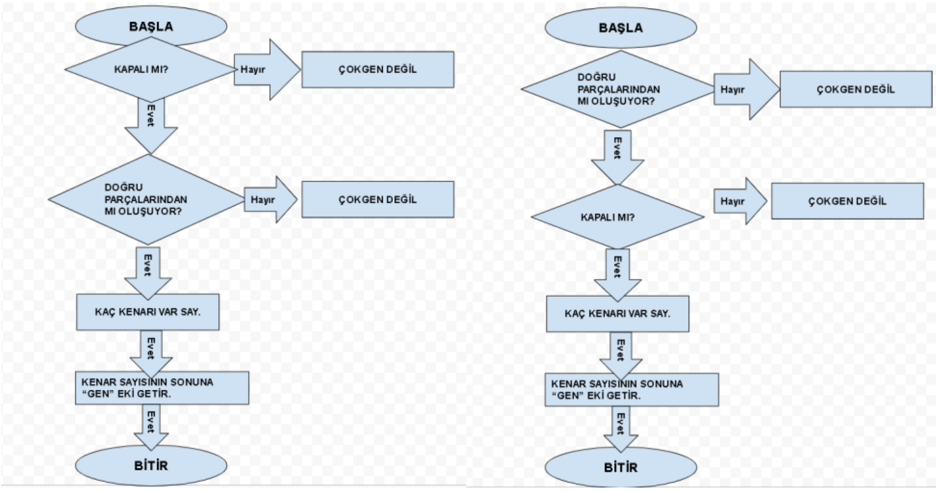


Fig. 13 The correct flowchart for the activity "What's the name of the polygon?"

Burak: The first week he did not give any answer to the questions, but the second week he replied to the all the questions, though not all were correct, he seems to be listening because he remembered the naming of the triangles but he confused the classification. For instance, instead of "çeşitkenar üçgen," the scalene triangle; he wrote "çeşitli üçgen".Yet, the misunderstanding was only in the naming of the triangles. In the fourth week, he gave correct answers to the questions about angles. In the fifth week, although he answered the question asking for metric conversion information correctly, he could not solve the problem that he needed to use this information.

For Burak and his group (Ayşe and Ömer), cooperation could not be achieved in the robot's route activity, they could not distribute the task within the group. Since they were constantly interrupting each other’s words, at the beginning, they wrote the steps separately in their notebooks and eventually uploaded Ayşe’s work in the file. What they created in “The Route of the Robot” can be seen in the below figure, although the result was correct, the process was not very efficient. Burak and Ömer may not have done anything on their notebooks. Ayşe shared her work (see figure 14), Burak and Ömer just waited through the activity.

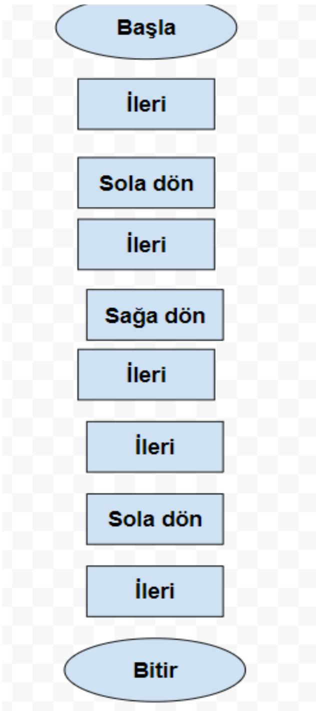


Fig. 14 The artifact of “Route of the robot” activity created by Burak, Ayşe, and Ömer

Ayşe (ceiling effect): Stating with the first week, Ayşe showed the highest performance in the class. Her 1st week’s assignment different from all other students in that she indicated that the shape must have 2 dimensions to be defined as a polygon. She gave the right answers to almost all of the questions of in the weekly assignments, except for the quadrilateral family in the 3rd week.

CHAPTER 5

DISCUSSION AND CONCLUSIONS

This study investigated the mathematics-oriented epistemological beliefs of middle school students and examined whether instructional design integrating Math and ICT curricula for 5 weeks would improve 5th-graders' algorithmic thinking and problem-solving skills and their mathematics oriented epistemological beliefs. The instructional units, which covered 6 Math and 8 ICT objectives, were designed based on the Arc of Learning framework. The results showed that while there is not a statistically significant change in the mathematics-oriented epistemological beliefs, students' algorithmic thinking and problem-solving abilities were significantly improved after the implementation.

5.1 Improvement of mathematics oriented epistemological beliefs

The analysis of the 193 middle school students' MOEBS scores in the district showed no meaningful correlation between grade level and MOEBS, even if the youngest in the group (5^{th} graders) scored the lowest. Although Schommer (1993) and Cheney, Kuhn, and Weinstock (2000) claimed that there is a directly proportional relationship between age and epistemological beliefs, this study could not support that relationship. The reason behind this may be that in the two studies mentioned, the authors worked with participants who were from older age groups—both were at least high school level participants.

It is also possible that the 5-week intervention was not long enough to make a change in beliefs, which is actually the most difficult to change. However, it was also argued by Kienhues, Bromme, and Stahl (2008) that improvement of epistemological beliefs can be possible even after a short-term intervention. Also, Kienhues et al. (2008), and Valanides and Angeli (2005) claimed that the type of instruction that enables collaboration and group work can also affect the sophistication of students' epistemological beliefs. However, this study did not corroborate these findings, because the increase in the 5th graders' MOEBS scores after a five-week intervention was not statistically significant. On the other hand, as Gu (2016) mentioned PBL might not positively affect some students' epistemological beliefs as expected; she found that even though students' self-reported epistemological beliefs were becoming more sophisticated, their revealed epistemological beliefs was not sophisticated. It is also accepted by other researchers that while PBL instruction can cause increases in epistemological beliefs of high achievers, it may not cause increases for low achievers (e.g. Belland et al., 2019). As Gu (2016) indicated that the reason why epistemological beliefs are sophisticated in self-reported results but they were not actually increased might be that students' low-meta-cognition, especially at lower grade levels Therefore, the reason why the epistemological beliefs in this study did not increase as expected might be because the self-reported data may be problematic in capturing the younger students' actual epistemological beliefs.

Lastly, many researchers found a relation between mathematical achievement and epistemological beliefs (Steiner, 2007; Muis, 2004); and more sophisticated mathematics oriented epistemological beliefs were related to better problem-solving skills (Schommer-Aikins et al., 2005). However, for the 5th graders in this study, even though the mathematics and ICT unit scores and algorithmic thinking and problem-solving skills were positively correlated, there was no significant correlation between the self-reported epistemological beliefs with the unit tests or problem-solving skills. Further, there were times when students' self-reported epistemological beliefs did not match with the artifacts and observations made during the lessons. For example, Zehra had a pre-MOEBS score of 108 and Faruk had a score of 92, both had lower scores on the post-MOEBS data; however, in the “Mystery of Diagonal” activity, when Zehra showed that she had drawn a diagonal to the triangle, Faruk told her that this drawing did not look correct because it go from corner to a corner, maybe the triangle did not have a diagonal. In response to this, Zehra said, "The teacher drew a diagonal to a square, pentagon, or even a decagon. How can a triangle not have a diagonal, of course it has." In this case, Faruk shared his screen again and tried to draw the line segments connecting the corners, but each time he saw that these drawings formed an edge, he concluded that there is no diagonal in the triangle. As it can be seen here, Zehra followed the teacher’s demonstration, and avoided exploring and coming up with a separate solution through her own thinking, while Faruk, who had a lower score on the self-reported MOEBS, showed more sophisticated epistemological beliefs. Therefore, it is possible that the data collected to interpret the mathematics oriented epistemological beliefs through the scale may not present the real beliefs of the students A more reliable data collection procedure for mathematics oriented epistemological beliefs could be conducting cognitive interviews with students (Miller et al., 2014)

The findings related to the epistemological beliefs did not support most of the findings mentioned in the literature; however, another reason for this might be because of the participants’ age. The participants in this study were 5th graders, 10-11 years old; yet, the epistemological belief scale used in the study was originally designed for high school students. The scale’s items were assessed and retested for reliability at the middle school level, and was found reliable for this data, however, that the original items were not developed for this particular age level might still have some influence on the scores. In addition, the participants in this study were younger than most of the studies in the literature, where epistemological belief studies tend to be carried out with older age groups. Besides, Cheney et al (2000), Kurt (2009), and Onen (2011) found in their research with different age groups that students' epistemological beliefs developed proportionally with age, and that there must be at least one-year difference so that this development can be observed. In a study conducted with 2nd and 3rd grade students, it was noticed that it was very difficult to capture students in their transition from a naïve epistemological belief to more sophisticated level (Kuhn et al., 2000). Therefore, a longer period of time seems to be required for the students' epistemological beliefs to change, especially with younger age groups. A statistically significant transition may not have been observed in this study, because of the duration of the implementation.

5.2 Algorithmic thinking and problem-solving skill development

It is claimed that algorithmic thinking skills are correlated with problem-solving skills in Math (Mezak & Petra, 2018). Many researchers suggested that the instruction that aims to improve the algorithmic thinking skills also leads to more success in mathematical achievement (Demir & Cevahir, 2020; Walle et al., 2010). The findings of this study supported the positive relation between Math achievement and algorithmic thinking and problem-solving skills.

Moreover, many researchers claimed that instruction that enables students to assess the information they need to use to create proper algorithms to solve complex problems will improve students’ algorithmic thinking and problem solving abilities (Papert, 1980; Walle et al., 2010; Edson et al., 2019).This study provided support for similar findings in the literature,   as the fifth graders in this study significantly increased their algorithmic thinking skills, whereas the 6th graders, who did not receive PBL instruction, did not significantly improve their algorithmic thinking and problem-solving skills.

5.3 Mathematics and ICT improvement through class activities

According to research findings, the students who attended problem-based learning environments increased their mathematics achievement and they became more successful in problem solving (Hidi & Renninger 2006; Lu et al., 2018; Schmidt et al., 2011). In regards the specific framework of the PBL model, earlier research with 7th and 8th graders had shown that PBL courses designed in accordance with the Arc of learning framework improved students' math achievement and problem-solving skills (Ben-Chaim et al., 1997). The analysis of the data collected in this study also found a significant increase in Math as measured in a unit exam. after a PBL implementation based on the stages of Arc of Learning. This study's contribution was that the 5th graders simultaneously increased their scores in the ICT unit exam.

The analysis of student artifacts and observations of group interactions supported these findings based on the quantitative data. For example, in the first week, Merve said "this is not about math, I made a tree" because the shape she created in the "tangram algorithm" activity was not similar to the mathematical shapes she was used to, and she could not yet name the polygons appropriately. However, in the later stages of her practice, she began to acquire mathematical knowledge and to make inferences by associating pieces of this knowledge. For example, in the "code.org quadrilateral design" activity in the 3rd week, she realized that every square is a rectangle while creating the code blocks. Nida can be given as another example; this student was not very active in the lessons, and she was generally silent in group studies. The scores she got from artifacts and the scores she got from weekly assignments also show that she did not make much progress. That she correctly answered some of the questions measuring knowledge in the weekly assignments but could not do the rest or could not use the information given in problem solving support this inference. Quantitative data also corroborated the data collected during the learning process. Nida's scores showed either a decrease, which was in her ICT unit scores, or no change as in her ATPS scores and Mathematics unit tests scores in the post-tests.

5.4 Implications for practice and recommendations for future research

This study contributes to mathematics and ICT curricula and pedagogies of teaching both. First of all, integrated mathematics and ICT unit lesson plans were prepared around a PBL pedagogy. This is important for computational thinking skills, common to both mathematics and ICT courses as algorithmic thinking and problem solving are also components of computational thinking (Rich et al., 2020).

Although the importance of using information and communication technologies in Math lessons is underscored in Math education literature, these technologies are usually used as tools primarily to meet Math objectives, and examples of lessons in which the objectives of computer science and mathematics lessons are brought together are rare (if not non-existent). This study tried to fill an important gap in the field by developing and accessing a small scale integrated curriculum for mathematics and ICT in the 5th grade, designed specifically for remote delivery using video conferencing and other online tools.

Secondly, it is seen in this study that integrating the objectives of Math and ICT courses and providing students a problem-based learning model does not only increase the students' achievement levels in Math and ICT lessons, but also improves their algorithmic thinking and problem-solving skills. Also, the Arc of Learning framework as a problem-based learning model has proved to be a useful guide for integrating relevant Math and ICT units.

In this study, the lessons designed in accordance with the Arc of learning framework were implemented only with 5th grade students, it is recommended that the effects of this framework be studied in other grade levels, and other units of Math and ICT integration designed for remote delivery can be further explored.

Due to the Covid-19 pandemic, most of this work was carried out remotely, using video conferencing and instant messaging tools. When K-12 schools switched to hybrid education in the last weeks of the 2020-2021 academic year due to the decision of the Ministry of National Education, several activities in the final week were conducted face-to-face, while some were done remotely. Despite all these dynamic changes, the implementation was completed successfully. However, it is recommended that problem-based integrated Math and ICT courses be replicated in the physical classroom, as face-to-face interaction has many obvious advantages for group work.

In the feedback collected from the students in this study, 14 students stated that the mathematics and ICT lessons were fun during the 5 weeks implementation, they were not bored in the lessons, dealing with the questions as group work with their friends was better than the lessons taught from the textbook. This provides support for the argument in the literature that real-world Math problems targeting higher-order thinking will be more engaging for the students (Schmidt et al., 2022), though engagement was not addressed as a research question in this study.

Even though there was no research question about the students' engagement in the process of remote learning through the implementation, the researcher was unexpectedly surprised to see that the students were engaged during most of the implementation, and how quickly they were able to adapt to the changing conditions The students were expected not only to adopt a new model of learning, but also attend lessons and follow content delivered over videoconferencing, work collaboratively with other students in electronic breakout rooms with intermittent support from the teacher, and learn to keep an electronic record of their work, which they were totally unfamiliar with. They needed to capture and send their artifacts during the lesson time, , while at the same time they needed to overcome technical problems, and manage household issues. Although they had difficulties in taking screenshots or using the applications in the activity during the early days of the implementation, they improved tremendously in the final weeks, as they were able to take screenshots of the artifacts and send them instantly to the teacher and share their screens as they worked on a group task, as well as when they had questions to ask.

It was found that the implementation in this research predicted changes in the students' algorithmic thinking, problem solving, and achievement in both mathematics and ICT. The implementation was an attempt at integrated curriculum designed in a problem-based model Partially due to the unusual circumstances, it was difficult to discern whether the characteristics of PBL, such as collaboration in group work, or the integration of the two subjects, or remote delivery caused the significant difference on the variables selected.

Firstly, the effect of the PBL model cannot be ignored in this change, it has been observed that in this learning model, students listen to each other's views and contribute to each other's ideas; for instance, in the activity called "The mystery of diagonals", Merve noticed that the number of diagonals from a vertex was 3 less than the total number of vertices, and when she shared this with her group, her groupmates also tried it on various polygons and confirmed this claim. When Merve asked “Why there is always 3 missing? One is the corner itself, but what is the reason for the other two?” Nida, another group member, replied: “Because the junction of a vertex with the previous or the next vertex is an edge, it doesn't count as a diagonal.". As seen in this interaction, students were able to construct knowledge in a learning model where they could exchange ideas with each other, combining with the new information they had acquired. Even Nida, who had no improvement in her mathematics and ICT unit tests, or her ATPS scores, make a great contribution in the discussion.

Secondly, as for the integrated curriculum; at the beginning some of the students named polygons by looking directly at the number of vertices or sides, however, towards the end of the week, in the "Name the polygon" activity, when the student identifying polygons, it was observed that they first made comments such as "we must first understand whether it is a polygon", "let's go step by step", "first we need to check whether it is a polygon or not then count the corners later". In the following weeks, they stated that it was easier to solve problems by going step by step in mathematics lessons. On the other hand, they continued to use their mathematics knowledge in the ICT lessons too, for instance, in the "Code.org Quadrilateral design" activity, the students realized that while using the code blocks, they would make ninety-degree rotations each time, so it was more convenient to create loops. Some students realized that they used rectangular properties while creating a square, and therefore realized that every square can also be a rectangle. This shows that the integration of mathematics and ICT courses has been effective for both fields, with this group of students.

Lastly, during remote instruction due to the Covid-19 pandemic, various online tools were used to support both mathematical understanding and group work, in addition to the videoconferencing tool. In studies conducted during the pandemic, it was found that there were some advantages of these unusual circumstances: using web based materials with no limitation of the number of materials that many students could record or see different solutions by taking screenshots, or that the positive influence of dynamic visuals on students' spatial thinking skills (Livy et al., 2022). Also in this study, unexpected positive outcomes emerged from unusual and difficult circumstances, the fact that the students were able to see the work of their classmates, and that each could use many software tools or online manipulatives individually, thanks to access to a phone, tablet, or computer, may have contributed to a significant positive change in the variables aimed by the implementation in this study.

5.5 Limitations of the study

Due to the Covid-19 pandemic, the students attended the classes remotely, which negatively affected the number of participants in the study. In addition, the study was based on the problem-based learning model and one of the features of this model is that students do group work. However, in the PBL lessons performed remotely, group work may not have been as productive as face-to-face instruction because of technical deficiencies. On the other hand, as the teacher of the implementation, I have often used the breakout rooms feature on the Zoom so that students can spend their group work more efficiently. Thanks to this feature, I was able to assign the students into groups according to the number of group members planned. I visited the rooms during the activities, so that if the groups had questions, I facilitated them to solve these questions.

Furthermore, even though teaching remotely over video conferencing leads to problems such as deficiencies in group discussions, not being able to observe students at the same time, not being able to notice those who are playing games or doing other activities during the lesson, it has also played an important role in many activities in this application since each student had their own technological tools and used them independently. For example, if the coding studies on code.org were done face-to-face in the classroom, it would not be possible for the students to work individually because there is only one smart board in the classroom.

Yu et al. (2015) found that as a result of instructing in 3 different modes, such as, blended PBL, PBL and conventional teaching models, the highest achievement was in the blended PBL group, and the second highest was in the PBL group. For this reason, it was expected that the students in the distant PBL model in this study would be more successful than a traditional approach, but it was not possible to do a comparison, since there were no face-to face classes, and also, a comparison of achievement at the same grade level could not be performed. Although mathematics and ICT achievements could not be compared with non-PBL group at the same grade level, data from 6th grade students in the same school were used to compare algorithmic thinking and problem-solving skills. Although the control and experimental groups were at different grade levels, these two classes were taught the same learning outcomes in the ICT course because the 6th graders did not take an

ICT course in the previous year. In addition, ATPS pre-tests of these two groups were compared and it was found that there was no significant difference between them.

APPENDICES

APPENDIX A

PERSONAL INFORMATION FORM (TURKISH)

Sevgili Öğrenciler,

Aşağıda sizden bazı kişisel bilgiler istenmektedir. Burada sorulan sorular araştırmada kullanılmak için istenildiği için sizden dürüstçe cevaplamanızı rica ediyorum ve verdiğiniz bilgilerin benim (araştırmacı) dışında kimse tarafından bilinmeyeceğini belirtmek isterim. Araştırmama katkılarınızdan dolayı çok teşekkür ederim.

Dilek Turan

Okul:
Sınıf/Şube:
Cinsiyet:
Annenizin eğitim durumunu: ( ) Hiç okula gitmemiş ( ) Lise ( ) İlkokul ( ) Üniversite ( ) Ortaokul Çalışıyorsa mesleği: ……………………………………….
Babanızın eğitim durumu: ( ) Hiç okula gitmemiş ( ) Lise ( ) İlkokul ( ) Üniversite ( ) Ortaokul Çalışıyorsa mesleği: ……………………………………….
Uzaktan eğitim sürecinde kullandığın cihaz: ( ) Kullanabileceğim bir cihaz yok ( ) Telefon ( ) Tablet ( ) Bilgisayar Bu cihazı evde başka kimler kullanıyor? ____

APPENDIX B

PERSONAL INFORMATION FORM

Dear Students,

Below you are asked for some personal information. Since the questions asked here are asked to be used in the research, I ask you to answer honestly and I would like to state that the information you provide will not be known to anyone other than me (the researcher). Thank you very much for your contribution to my research.

School:
Class:
Gender:
Your mother's educational status: ( ) Never went to school ( ) High School ( ) Primary School ( ) College ( ) Middle School Occupation if working: …………………………………………….
Your father’s educational status: ( ) Never went to school ( ) High School ( ) Primary School ( ) College ( ) Middle School Occupation if working: …………………………………………….
The device you used in the distance education process: ( ) There is no device I can use ( ) Phone ( ) Tablet ( ) Computer Who else uses this device at home? ____

APPENDIX C

MATHEMATICS ORIENTED EPISTEMOLOGICAL BELIEFS

	Kesinlikle katılmıyorum (1)	Katılmıyorum (2)	Kararsızım (3)	Katılıyorum (4)	Kesinlikle katılıyorum (5)
1. Bir öğrencinin matematiği ne kadar iyi öğrenebileceği ne kadar çaba harcadığına bağlıdır.					
2. Ne kadar yetenekli olursanız olun, çaba harcamadan matematik alanında başarılı olamazsınız.					
3. Yalnızca çok çaba gösteren kişiler iyi bir matematikçi olabilirler.					
4. İnsanların matematik başarılarındaki farklılık gösterdikleri çabanın farklı olmasından kaynaklanmaktadır.					
5. Gerçekten çaba harcarsa her birey matematik öğrenebilir.					
6. Matematik alanındaki zor konuları yalnızca çok çaba sarf eden bireyler öğrenebilir.					
7. Matematik alanındaki bir konuyu hemen anlamayan bir öğrenci anlamak için çabalamayı sürdürmelidir.					
8. Matematik alanında çaba göstermeden bilgi sahibi olunamayacağını bilmek matematik alanında başarılı olabilmenin ilk adımıdır.					
9. Matematik alanındaki en başarılı insanlar en fazla çaba harcayan insanlardır.					
10. Doğru çalışma becerilerini öğrenmek bireyin matematik yeteneğini geliştirebilir.					
11.İnsanlar yeni şeyler öğrenebilirler ancak sahip oldukları matematik yeteneğini değiştiremezler.					
12. Matematik alanında başarılı olan insanlar doğuştan matematik yeteneğiyle dünyaya gelmiş olan kişilerdir.					
13. İnsanların çoğu erken yaşlardan itibaren matematik alanında başarılı olup olamayacaklarını bilirler.					

14. Bir matematik problemini birkaç dakika içinde çözemeyen bir öğrenci ne kadar çaba harcarsa harcasın muhtemelen problemi çözemeyecektir.					
15. Yalnızca matematik alanında yetenekli olan kişiler iyi bir matematikçi olabilirler.					
16. İnsanların matematik başarılarındaki farklılık matematik yeteneklerinin farklı olmasından kaynaklanmaktadır.					
17. Matematik alanındaki zor konuları, yalnızca matematik alanında yetenekli olan insanlar öğrenebilir.					
18. Matematik yeteneği olmayan bir öğrencinin matematik öğrenmek için çaba harcaması vakit kaybıdır					
19. Ne kadar çabalarsanız çabalayın matematik alanındaki başarınızı bu alandaki yetenekleriniz belirler					
20. Matematik alanında yetenekli olmayan bir öğrencinin bu alanda başarılı olabilmek için yapacak çok şeyi yoktur					
21. Matematik alanında kuram (teori) haline gelmiş bir bilginin yanlış olması mümkün değildir.					
22. Matematik alanındaki konular tartışmaya açık değildir.					
23. Matematik alanındaki her konu hakkında yalnızca tek bir doğru vardır.					
24. Matematik alanındaki doğrular değişmezdir.					
25. Matematik alanında, bugün doğru olduğu düşünülen bir bilginin ilerleyen zamanlarda yanlış olduğu anlaşılabilir.					
26. Matematik alanındaki herhangi bir konu farklı bakış açılarıyla ele alınsa da o konuya ilişkin ancak tek bir doğru olabilir					
27. Matematik alanında hakkında en fazla bilgiye sahip olunan konuların bile doğrulukları sorgulanabilir.					

APPENDIX D

ALGORITHMIC THINKING AND PROBLEM SOLVING SCALE (TURKISH)

Ad Soyad:

Okul ve sınıf:

Buradaki soruları çözerken yaptığınız hiçbir işlemi silmeyiniz.   ***Elinizden geldiği kadar her soru için yorum/işlem yapmaya çalışınız.***

Soru 1) İki basamaklı bir sayının 999 ile çarpımından elde edilen sonucu kısa yoldan hesaplamak için alttaki adımlar izlenir.

1. 999 ile çarpılan sayıdan 1 çıkarılır.
2. 999'dan birinci adımda elde edilen sayı çıkarılır.
3. Birinci ve ikinci adımda elde edilen sonuçlar yan yana yazılır.

Örneğin, 17 x 999 çarpımı

1) 17 - 1 = 16
2) 999 - 16 = 983
3) 16983'dir.

24 x 999 işleminin sonucunu yukarıda verilen kısa yoldaki basamakları kullanarak bulunuz. Sonucu bulurken örnekteki gibi adım adım ilerleyiniz.

1)
2)
3)

Soru 2) Kesirlerde bölme işlemi yaparken aşağıdaki adımlar izlenir.

1. Birinci kesir aynen yazılır
2. İkinci kesir ters çevrilir (payı ve paydası yer değiştirilir.)
3. 1. ve 2. adımda oluşan kesirlerin payları çarpılır ve paya yazılır.
4. 1. ve 2. adımda oluşan kesirlerin paydaları çarpılır ve paydaya yazılır.

Örnek:

$\frac{2}{5} : \frac{3}{7}$ işleminin sonucunu yukarıdaki adımları takip ederek bulalım.

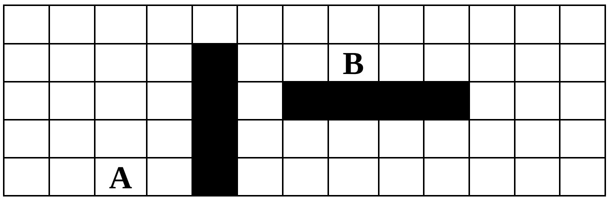
1. $\frac{2}{5}$	
2. $\frac{7}{3}$	
3. 2.7 = 14	$\frac{14}{}$
4. 5.3 = 15	$\frac{14}{15}$

$\frac{5}{6} : \frac{2}{7} = ?$ **işleminin sonucunu yukarıda verilen sırayı takip ederek bulunuz. Sonucunuzu bulurken örnekteki gibi adım adım ilerleyiniz.**

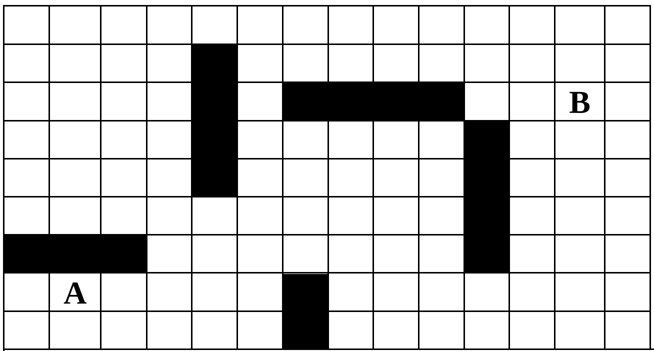
1.
2.
3.
4.

Soru 3) Aşağıdaki tabloda “**A”** kutucuğunda duran bir kişi **“B”** kutucuğuna ulaşmak istiyor, fakat siyah olan bölgeler üzerinden geçemiyor. Hedefine ulaşmak için en kısa yoldan nasıl gidebileceğini aşağıda tarif edilmiştir.

1) Kuzeye 4 adım git.
2) Doğuya 5 adım git
3) Güneye 1 adım git.



Aşağıdaki haritaya göre “A” dan “B” ye ulaşmak için <u>en kısa</u> yoldan nasıl gidebileceğini altındaki boşluğa adım adım yazınız. Örnekteki gibi yönleri kullanarak yazınız.



1)
2)
3)
4)
5)

Soru 4) İki basamaklı bir sayı ile 11’i çarparken aşağıdaki yöntem kullanılarak kolaylıkla çarpma işlemi yapılır.

1) Sayının rakamları toplanır.
2) Eğer toplamları dokuzdan büyükse toplamın ilk basamağı ve sayının 1.rakamı toplanır.

3) Toplamda çıkan sayı iki basamaklı sayının rakamları arasına yazılır.
4) 3. Adımda çıkan sayının ilk iki basamağı toplanır.
5) 4.Adımdaki toplam 1.basamağa yazılır sayının gerisi aynı kalır.

Örnek: 58 x 11 işleminin sonucunu bulalım.

1) Sayının rakamlarını topla: 5+8 = 13
2) Toplam 9'dan büyük
3) Sonucu sayının rakamları arasına yaz: 5**13**8
4) İlk iki rakamı topla: 5+1 =6
5) 4.adımı ilk basamağa yaz son iki basamağı da devamına: **6**38

Bu yönteme göre 79 x 11 işleminin sonucu kaçtır? Direkt çarpma işlemi yaparak değil yukarıdaki yöntemi takip ederek adım adım bulunuz.

1)
2)
3)
4)
5)

Soru 5) Bir sayının 3 ile tam bölünüp bölünmediğini anlamak için aşağıdaki adımlar izlenir.

1) Verilen sayının basamaklarındaki bütün rakamlar toplanır.
2) Toplam 3 ile bölünür
3) Eğer toplam 3'e bölündükten sonra kalan 0 ise verilen sayı 3'e tam bölünebilir, değilse verilen sayı 3'e tam bölünmez.

Örnek: 197 sayısı 3 ile tam bölünebilir mi?

1) 1+9+7 = 17
2) $\begin{array}{r\|l} 17 & 3 \\ \cline{2-2} \underline{-\;15} & 5 \\ 2 & \end{array}$
3) Kalan 0 değil, 197 sayısı 3'e tam bölünmez.

Yukarıdaki kısayolu kullanarak 2649 sayısının 3'e tam bölünebilirliğini inceleyiniz. Yukarıdaki yöntemi takip ederek adım adım bulunuz, direkt sonuç yazılması kabul edilmeyecektir.

1)
2)
3)

Soru 6) Bir spor salonunun her biri 70 tl ödeyen 60 üyesi vardır. Spor salonu bu üyelerden 4200 TL gelir elde etmektedir. Salon sahibi daha çok gelir elde etmek için üyelik ücretini düşürmeyi planlıyor ve her 10 TL'lik indirime 40'ar yeni öğrenci geleceğini düşünüyor. Spor salonunun sahibi alttaki tabloyu doldurarak en fazla gelir elde edeceği ücreti bulmak istiyor. İlk iki satırı dolduruyor.

En fazla gelir elde edeceği ücret kaçtır? Tablonun geri kalanını doldurarak sonuca ulaşınız.

Üyelik Ücreti	Üye Sayısı	Gelir
60 TL	100	60 x 100 = 6000 TL
50 TL	140	50 x 140 = 7000 TL

Soru 7) Aslı ve Burak kim daha hızlı koşuyor diye yarışmaya karar verdiler. Aslı 7 metreyi 4 saniyede koşarken, Burak 5 metreyi 3 saniyede koşmaktadır.

Koşu hızlarını hiç değiştirmezlerse 35 metrelik yolu ilk kim tamamlamış olur? Nasıl bu sonuca ulaştığınızı açıklayınız. Aşağıdaki tablolardan yararlanarak sonuca ulaşabilirsiniz.

Aslı	
Süre	**Mesafe**
4. sn	7 metre
8. sn	14 metre
12. sn	21 metre

Burak	
Süre	**Mesafe**
3. sn	5 metre
6. sn	10 metre
9. sn	15 metre

Soru 8) Kaplumbağa ve tavşan hız yarışı yapmaktadır. Her saat başı bu iki hayvanın ne kadar mesafe gittikleri kontrol edilir.
Tavşan ilk başladığında 1 saatte 100 metre gitmiş fakat çok hızlı gittiği için yorulmuş bu yüzden sonraki 1 saatte 90 metre gidebilmiştir, sonraki 1 saatin sonundaysa sadece 80 metre gidebilmiş, yani her saatin sonunda 10 metre daha az gidebildiği fark edilmiştir. Kaplumbağa ise 1 saatte 70 metre mesafe gider ve hızı hiç değişmez.

Buna göre kaç saat sonunda kaplumbağa tavşanı geçer? Aşağıdaki tablonun devamını doldurarak sonuca ulaşınız.

Süre	Tavşanın bulunduğu konum	Kaplumbağanın bulunduğu konum
1. saat	100 m	70 m
2. saat	190 m	140 m
3. saat	270 m	210 m
4. saat	340 m	280 m

Soru 9) Aksaray Müzesine girmek isteyen Ali ve Gizem isimli iki kardeş girişte bilet almak için görevliye bilet fiyatını sorarlar. Müze görevlisi, iki kardeşe 3 farklı ücretlendirme seçeneği olduğunu söyler.

1.Seçenek: TEK BİLET	**2. Seçenek: AYLIK ÜYELİK**	**3. Seçenek: <u>AİLE</u> AYLIK ÜYELİK**
3 TL *<u>Bir</u> kişi yalnızca bir defa giriş yapabilir.*	**8 TL** *<u>Bir</u> kişi bir ay boyunca istediği kadar giriş yapabilir.*	**17 TL** *<u>Ailedeki herkes</u> bir ay boyunca istediği kadar giriş yapabilir.*

Ali ve Gizem bu ay müzeye 3 defa gitmeyi planlıyorlarsa hangi seçeneği tercih ederek en karlı giriş yöntemini seçmiş olurlar? Neden o seçeneğin en karlı olacağını düşünüyorsunuz açıklayınız.

Soru 10) Bir çikolata satış mağazası çikolata fiyatına yapılacak her 1 TL'lik zammın günde 20 tane daha az çikolata satılmasına neden olacağı öngörüyor. Mevcut durumda çikolatayı 2 TL'den satıyor. Günde 200 çikolata satarak 400 TL gelir elde ediyor.

Mağaza sahibi alttaki tabloyu doldurarak en fazla gelir elde edeceği çikolata fiyatını bulmak istiyor. İlk iki satırı dolduruyor.

En fazla gelir elde edeceği çikolata fiyatı kaçtır? Tablonun geri kalanını doldurarak sonuca ulaşınız.

Çikolata Fiyatı	**Satılan Çikolata Adedi**	**Gelir**
2 TL	200	2 x 200 = 400 TL
3 TL	180	3 x 180 = 540 TL

APPENDIX E

ALGORITHMIC THINKING AND PROBLEM SOLVING SCALE

Name:

School and grade level:

Do not delete any operation you have done while solving the questions here. Try to make comments/actions for each question as much as you can.

Question 1) To calculate the result obtained by multiplying a two-digit number by 999, the following steps are followed.

1. Subtract 1 from the number multiplied by 999.
2. Subtract the number obtained in the first step from 999.
3. The results obtained in the first and second steps are written side by side.

For example, the product of 17 x 999

1) 17 - 1 = 16
2) 999 - 16 = 983
3) 16983'dir.

Find the result of 24 x 999 by using the steps in the shortcut given above. While finding the result, proceed step by step as in the example.

1)
2)
3)

Question 2) The following steps are followed when dividing fractions.

1. The first fraction is written exactly as it was
2. The second fraction is reversed
3. The numerators of the fractions in the 1st and 2nd steps are multiplied and written into the numerator.
4. The denominators of the fractions in the 1st and 2nd steps are multiplied and written in the denominator.

Sample: Let's find the result of 2/5 : 3/7 by following the above steps.

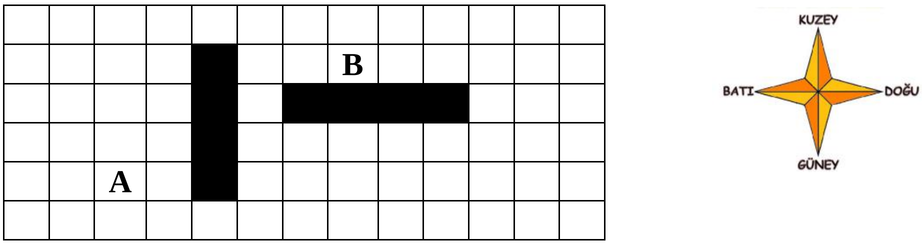
1.	$\frac{2}{5}$	
2.	$\frac{7}{3}$	
3.	2.7 = 14	$\frac{14}{}$
4.	5.3 = 15	$\frac{14}{15}$

$\frac{5}{6} : \frac{2}{7} = ?$ **Find the solution by following the given steps.**

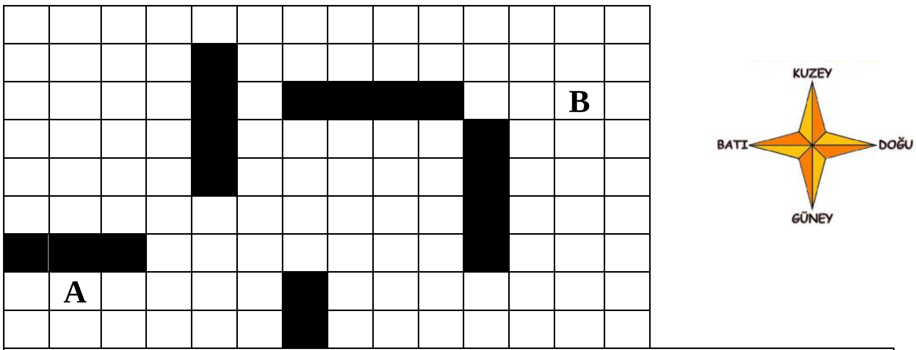
1.
2.
3.
4.

Question 3) In the table below, a person standing in the "A" box wants to reach the "B" box but cannot pass over the black areas. Here's how you can take the shortest route to reach your destination.

1. Take 4 steps north.
2. Take 5 steps east
3. Take 1 step south



According to the map below, write step by step in the space below how you can go from "A" to "B" in the shortest way. Write using the directions as in the example.



1)
2)
3)
4)
5)

Question 4) When multiplying 11 by a two-digit number, multiplication is easily done using the following method.

1. The digits of the number are added together.
2. If their sum is greater than 9, the first digit of the sum and the 1st digit of the number are added.
3. The total number is written between the digits of the two-digit number.
4. The first two digits of the number in step 3 are added.

5. The total in the 4^{th} step is written in the 1st digit, the rest of the number remains the same.

Example: Let's find the result of 58 x 11 operation.

1) 5+8 = 13
2) The sum is bigger than 9
3) 5**13**8
4) 5+1 =6
5) **6**38

According to this method, what is the result of 79 x 11 operation? Find step by step by following the above method, not by doing direct multiplication.

1)
2)
3)
4)
5)

Question 5) To find out if a number is divisible by 3, follow the steps below.

1. All digits in the digits of the given number are added together.
2. Total is divisible by 3
3. If the remainder is 0 after dividing by 3, the given number is divisible by 3, otherwise the given number is not divisible by 3.

Example: Is the number 197 divisible by 3?

1. 1+9+7 = 17
2. $\begin{array}{r\|l} 17 & 3 \\ \cline{2-2} -15 & 5 \\ \cline{1-1} 2 & \end{array}$
3. The Remainer is not 0, 197 is not divisible by 3.

Examine the divisibility of 2649 by 3 using the shortcut above. Find step by step by following the above method, direct results will not be accepted.

1.
2.
3.

Question 6) A gym has 60 members who pay 70 TL each. The gym earns 4200 TL from these members.
The owner of the hall plans to reduce the membership fee to generate more income and thinks that 40 new students will come to each 10 TL discount.
The owner of the gym wants to find the fee that will generate the most revenue by filling in the table below. It fills the first two lines.

What is the fee that will earn the most income? Get the result by completing the rest of the table.

Fee	Number of members	Income
60 TL	100	60 x 100 = 6000 TL
50 TL	140	50 x 140 = 7000 TL

Question 7) Aslı and Burak decided to compete to see who can run faster. While Asli runs 7 meters in 4 seconds, Burak runs 5 meters in 3 seconds.

Who will be the first to complete the 35-meter track if they never change their running speed? Explain how you came to this conclusion. You can reach the result by using the tables below.

Aslı	
Time	**Distance**
4^{th} seconds	7 meters
8^{th} seconds	14 meters
12^{th} seconds	21 meters

Burak	
Time	**Distance**
3^{rd} sec	5 meters
6^{th} sec	10 meters
9^{th} sec	15 meters

Question 8) The turtle and the rabbit are racing in speed. The distance traveled by these two animals is checked every hour.

When the rabbit first started, he went 100 meters in an hour, but he got tired because he went too fast, so he could go 90 meters in the next hour, and at the end of the next hour, he could only go 80 meters, that is, it was noticed that he could go 10 meters less at the end of each hour.
On the other hand, the turtle travels 70 meters in 1 hour and its speed does not change at all.

In how many hours will the turtle overtake the rabbit? Get the result by completing the rest of the table below.

Time	Rabbit's location	Location of the turtle
1st hour	100 m	70 m
2nd hour	190 m	140 m
3rd hour	270 m	210 m
4th hour	340 m	280 m

Question 9) Two siblings, Ali and Gizem, who want to enter the Aksaray Museum, ask the attendant for the ticket price to buy tickets at the entrance. The museum attendant tells the two brothers that there are 3 different pricing options.

1: One Ticket	2: Monthly membership	3: Monthly membership for family
3 TL	**8 TL**	**17 TL**
A person can only log in once.	*A person can log in as many times as they want for a month.*	*Everyone in the family can log in as many times as they want for a month.*

If Ali and Gizem are planning to go to the museum 3 times this month, which option will they choose the most profitable entry method? Explain why you think that option would be the most profitable.

Question 10) A chocolate store predicts that every 1 TL hike in the price of chocolate will result in 20 fewer chocolates being sold per day. Currently, it sells chocolate for 2 TL. He earns 400 TL by selling 200 chocolates a day.

The store owner wants to find the price of chocolate that will generate the most revenue by filling in the table below. It fills the first two lines.

What is the price of chocolate that will generate the most income? Get the result by completing the rest of the table.

Chocolate price	Number of Chocolates Sold	Income
2 TL	200	2 x 200 = 400 TL
3 TL	180	3 x 180 = 540 TL
..		
…		

APPENDIX F

ICT UNIT TEST (TURKISH)

1. “Akış Şeması bir sürecin adımlarını görsel ya da sembolik olarak gösterir ve matematik dersinde de öğrendiğimiz şekillerden oluşurlar. Farklı hareketler için farklı şekiller kullanılır.” **Aşağıdakilerden hangisi akış şemalarında kullandığımız şekillerden değildir?**

a. Dikdörtgen
b. Üçgen
c. Paralelkenar
d. Elips

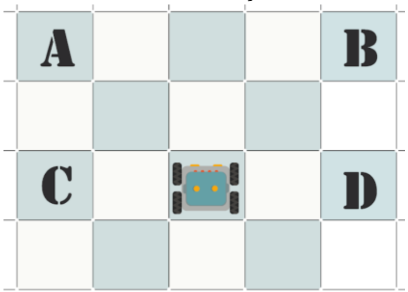
2. Ortaköy’de oturan Burak’ın “Sezgi” ilçesine gitmek için otobüse binmesi gerekiyor. Her otobüs gideceği yerin ismine göre isimlendirilmiş ve aşağıda bazı ilçelere giden otobüsle ile o otobüslerin numaraları verilmiştir.

GÜL = 479
ESKİL = 31659
GÜZEL = 47839

Bu durumda “SEZGİ” ye gitmek isteyen Burak kaç numaralı otobüse binmelidir?

a. 68452
b. 13845
c. 2856
d. 12467

3. Aşağıdaki görselde robot A noktasına gitmek istiyor, hangi şıktaki algoritmayı kullanarak A noktasına ulaşabilir?



a. BAŞLA-SOLA DÖN-İLERLE-İLERLE-BİTİR
b. BAŞLA–İLERLE–İLERLE–SOLA DÖN–İLERLE–İLERLE– BİTİR
c. BAŞLA – İLERLE – SOLA DÖN – İLERLE- İLERLE – BİTİR
ç. BAŞLA – SAĞA DÖN – İLERLE – İLERLE – SAĞA DÖN – BİTİR

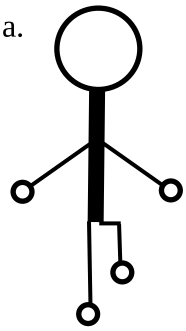
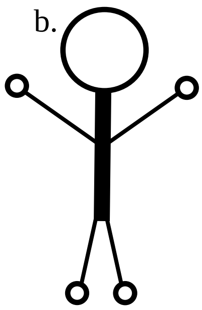
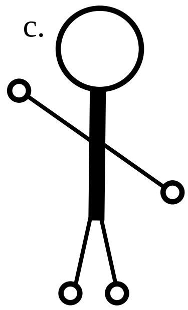
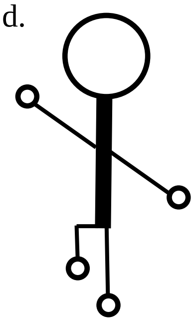
4. "Bir problemin çözümünde izlenecek yol anlamına gelir ve problemin çözümünün adımlar halinde yazılmasıyla oluşturulur. Her adımda yapılacak işlemler açıkça belirtilir.” **Bu cümlede açıklaması yapılan kavram aşağıdakilerden hangisidir?**

a. Veri
b. Değişken
c. Algoritma
d. Donanım

5. **Akış şeması hazırlarken farklı hareketler için farklı şekiller kullanılır. Akış şemasını başlatmak ve bitirmek için aşağıdaki şekillerden hangisini kullanırız?**
   a. Paralelkenar
   b. Dalgalı dörtgen
   c. Eşkenar dörtgen
   d. Elips

6. 23 Nisan için 5A sınıfı öğrencileri bir dans gösterisi düzenlemektedir. Öğretmenleri dansın hareketlerini bir kağıda yazmış ve bütün öğrencilerin bu hareketlere çalışmasını istemiştir. Aşağıda bu hareketlerin yazılı olduğu bir örnek vardır:
   1) İki kolunu da havaya kaldır
   2) Sağ kolunu indir
   3) Sağ ayağını havaya kaldır
   4) Sağ ayağını indir ve sol ayağını kaldır
   5) Eğer sol ayağın havadaysa sağ kolunu kaldır
   6) Sol ayağını indir.

   Bu hareketleri okulda prova eden aşağıdaki öğrencilerden hangisi son adımda doğru şekilde durmaktadır? (Öğrencilerin arkadan görüntüleri verilmiştir)

a.  b.  c.  d. 

7. Baba tavşan ve iki çocuk dereden karşıya geçmek istemektedir. Fakat tekne tek seferde sadece 6 kg ağırlık taşıyabiliyor. Baba tavşanın ağırlığı 6 kg, çocuk tavşanlar ise 3er kilogramdır. Hep beraber karşıya geçemeyeceklerini anlayan tavşanlar birkaç defa gidip gelmeleri gerekeceklerini fark ederler.

Baba tavşan ve çocukları ıslanmadan karşıya geçmek için teknenin derede en az kaç geçiş yapması gerekmektedir?

a. 3 b. 4 c. 5 d. 6

8. Bitir, Servise hazırla, Malzemeleri hazırla, Afiyetle ye, Yumurtayı kır, Başla, Tuz ilave et, Tavaya yağ koy
Yukarıda karışık halde verilmiş olan "yumurta kırma ve yeme" algoritmasını doğru şekilde düzenleyerek adım adım yazdığınızda aşağıdakilerden hangisi 6.adımda yer alır?

a. Malzemeleri hazırla
b. Bitir
c. Afiyetle ye
d. Servise hazırla

9. Bir problemin çözümü için aşağıdakilerden hangisi yapılmaz?

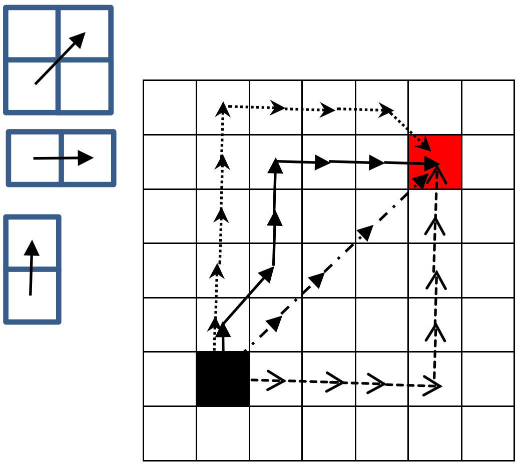
a. Problemi iyi anlamak.
b. Problemi çözmek için bir plan yapmak.
c. Problemi uzun ve karışık yollardan çözmeye çalışmak.
d. Problemi çözdükten sonra sonucu kontrol etmek.

10. Aslı okul çıkışında arkadaşlarıyla pastanede buluşacaktır, aşağıda okul ve pastanenin yerini gösteren kroki bulunmaktadır. Aslı bu krokideki yollardan birini tercih ederek pastaneye ulaşabilir. Fakat Aslı sadece aşağıda bulunan yönlerde hareket edebilmektedir.

Sağ üst çapraza gidebilir.

Sağa gidebilir.

Yukarı gidebilir.



Yukarıda belirtilen yönler dışında hareket edemeyen Aslı için aşağıdaki rotalardan hangisi uygun değildir?

a. ———— b. --------- c. ———— d. -·-·-·-

APPENDIX G

ICT UNIT TEST

1. “Flow Chart shows the steps of a process symbolically, and made up of the shapes we learned in math class. Different shapes are used for different movements.” **Which of the following is not a shape we use in flowcharts?**

a. Rectangle
b. Triangle
c. Parallelogram
d. Ellipse

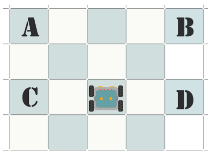
2. Burak, who lives in Ortaköy, has to take the bus to go to the town of "Sezgi". Each bus is named according to the name of the destination and the busses going to some districts and the numbers of those buses are given below.

GÜL = 479
ESKİL = 31659
GÜZEL = 47839

In this case, what number of bus should Burak take, who wants to go to “SEZGİ”?

a. 68452
b. 13845
c. 2856
d. 12467

3. **In the image below, the robot wants to go to point A, which algorithm can it use to reach point A?**



a. START-TURN LEFT-FORWARD-FORWARD-END
b. START-FORWARD-FORWARD-TURN LEFT-FORWARD-FORW- FINISH
c. START - FORWARD - TURN LEFT - FORWARD - FORWARD - FINISH
d. START – TURN RIGHT – ADVANCE – ADVANCE – TURN RIGHT – FINISH

4. "It means the way to be followed in solving a problem and it is created by writing the solution of the problem in steps. The actions to be taken at each step are clearly stated." **Which of the following terms is used in this sentence?**

a. Data
b. Variable
c. Algorithm
d. Equipment

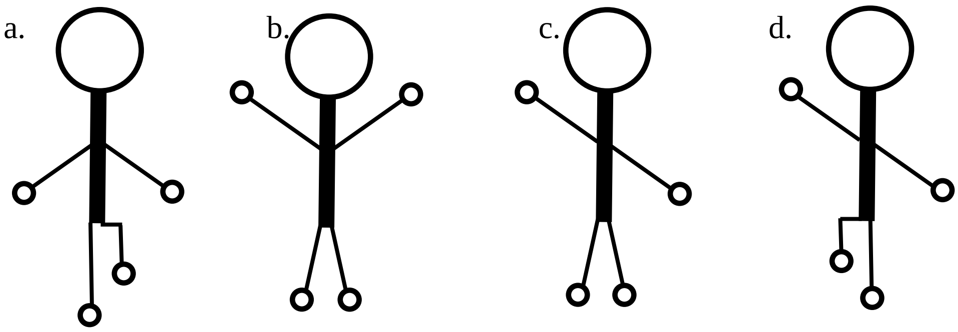
5. Different shapes are used for different movements while preparing a flow chart. **Which of the following figures do we use to start and end the flowchart?**

a. Parallelogram
b. Rectangle
c. Equilateral quadrangle
d. Ellipse

6. Students of class 5A are holding a dance show for April 23. The teachers wrote down the movements of the dance on a piece of paper and asked all the students to work on these movements. Below is an example of these gestures:

1) Raise both arms in the air
2) Lower your right arm
3) Raise your right foot in the air
4) Lower your right foot and raise your left foot
5) If your left foot is in the air, raise your right arm
6) Lower your left foot.

Which of the following students rehearses these movements at school correctly stands on the last step? (Back images of students are given)



7. The father rabbit and two children want to cross the stream. But the boat can only carry 6 kg at a time. The weight of the father rabbit is 6 kg, and the child rabbits are 3 kilograms. Realizing that they cannot cross the street together, the rabbits realize that they will have to go back and forth a few times.

At least how many crossings must the boat make in order to cross the river before the father rabbit and his children get wet?

a. 3 b. 4 c. 5 d. 6

8. Finish, Prepare to serve, Prepare the ingredients, Eat well, Crack the egg, Start, Add salt, Put oil in the pan

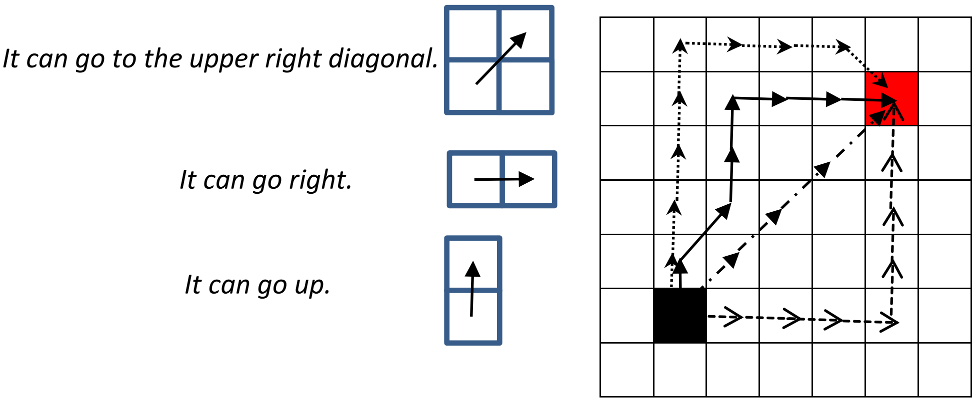
When you write the "breaking and eating eggs" algorithm, which is given above in a mixed form, step by step, by arranging it correctly, which of the following takes place in step 6?

a. Prepare the materials
b. Finish it
c. Eat with pleasure
d. Prepare to serve

9. Which of the following should not be done to solve a problem?

a. To understand the problem well.
b. Making a plan to solve the problem.
c. Trying to solve the problem in long and complicated ways.
d. Checking the result after solving the problem.

10. Aslı will meet her friends at the patisserie after school. Below is a sketch showing the school and the bakery. Asli can reach the patisserie by choosing one of the roads in this sketch. But Aslı can only move in the directions below.



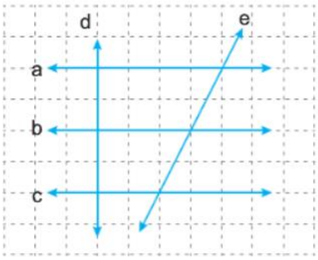
Which of the following routes is <u>not</u> suitable for Aslı, who cannot move outside the directions mentioned above?

APPENDIX H

MATHEMATICS UNIT TEST

Ad Soyad:

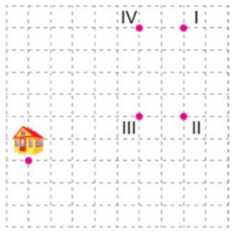
1)



Kareli zeminde verilen şekle göre aşağıdakilerden hangisi doğrudur?

A) a ⊥ e B) b ⊥ d C) d ⊥ e D) a ⊥ c

2)

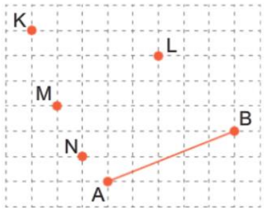


Yukarıdaki birimkareli zeminde evin konumu gösterilmiştir. Market, evin 6 birim sağında, 4 birim yukarısında ve okulun 1 birim solunda, 2 birim yukarısındadır.

Buna göre okulun yeri numarayla gösterilmiş yerlerden hangisidir?

A) I B) II C) III D) IV

3)

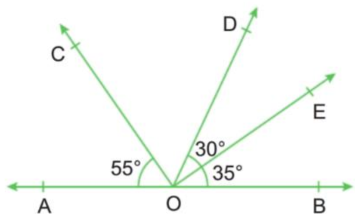


Kareli zemin üzerinde verilen noktalardan hangi ikisi birleşince AB doğru parçasına eş uzunlukta bir doğru parçası çizilmiş olur?

A) K ile L B) L ile M

C) L ile N D) K ile N

4)

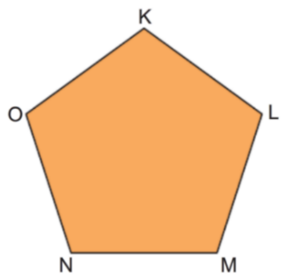


Şekildeki A, O ve B noktaları doğrusaldır.

Buna göre, aşağıdaki bilgilerden hangisi <u>yanlıştır</u>?

A) DOB açısı dar açıdır.
B) BOC açısı geniş açıdır.
C) COE açısı dik açıdır.
D) AOE açısı doğru açıdır.

5)



Yukarıdaki KLMNO beşgeninde kaç tane köşegen vardır?

A) 4 B) 5 C) 6 D) 7

6)

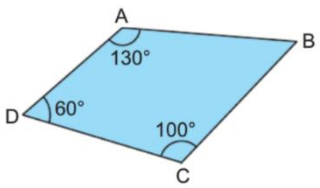
- Bütün kenarları eşit uzunluktadır.
- Köşegen uzunlukları eşittir.
- Bütün iç açıları 90° dir.

Yukarıda özellikleri verilen dörtgen aşağıdakilerden hangisidir?

A) Paralelkenar B) Eşkenar dörtgen

C) Dikdörtgen D) Kare

7)



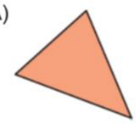
Yukarıdaki ABCD dörtgeninde verilenlere göre B açısı kaç derecedir?

A) 50 C) 60 C) 70 D) 80

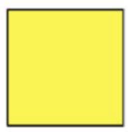
8)

Aşağıdakilerden hangisi çokgen değildir?

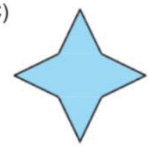
A)



B)



C)

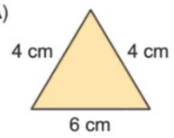


D)

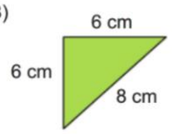
9)

Aşağıdaki üçgenler kenarlarına göre sınıflandırıldığında hangisi diğerlerinden farklıdır?

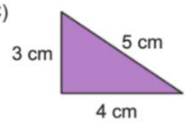
A)



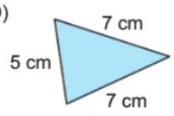
B)



C)



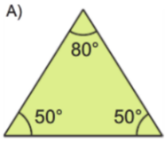
D)



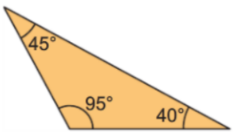
10)

Aşağıdaki üçgenlerden hangisi geniş açılı bir üçgendir?

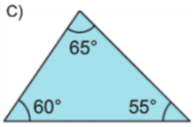
A)



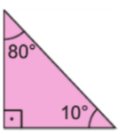
B)



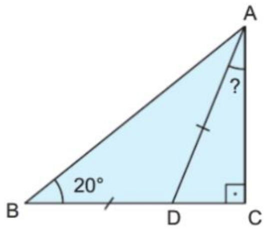
C)



D)



11)

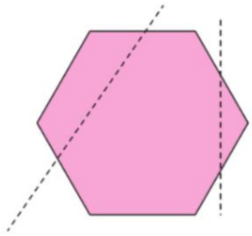


Şekildeki ABC dik üçgeninde [AC] ⊥ [BC], |BD| = |AD| olarak veriliyor.

Buna göre, $s(\widehat{DAC})$ kaç derecedir?

A) 50 B) 60 C) 70 D) 80

12)

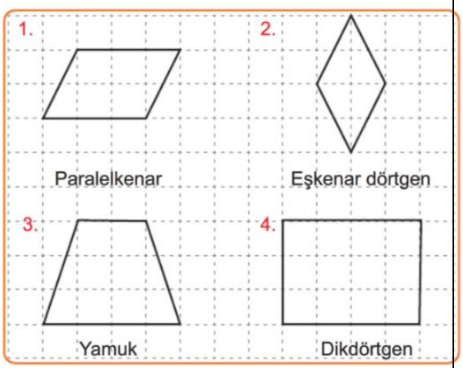


Yukarıda verilen çokgen şeklindeki bir kağıt işaretli yerlerden kesildiğinde kalan parça aşağıdakilerden hangisidir?

A) Yedigen B) Altıgen

C) Beşgen D) Dörtgen

13)

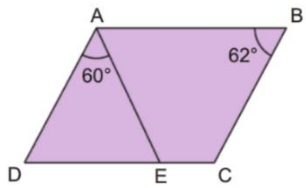


Yukarıda numaralandırılmış dörtgenlerden hangilerinin köşegen uzunlukları eşittir?

A) 1 ve 2 B) 2 ve 3

C) 3 ve 4 D) 1, 3 ve 4

14)



Yukarıdaki şekilde ABCD paralelkenarı verilmiştir.

Buna göre, $s(\widehat{AED})$ kaç derecedir?

A) 58 B) 60 C) 62 D) 64

15)

7345 cm = ...I... m ....II... cm

Yukarıdaki boşluğa gelmesi gereken sayılar aşağıdakilerden hangisidir?

	I	II
A)	73	45
B)	734	0,5
C)	734	5
D)	7300	45

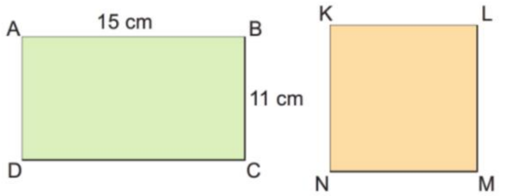
16)

Fatma 5,7 km uzaklıktaki okuluna gitmek için yola çıkıyor. 1760 m yürüdükten sonra ilk molayı, 3417 m daha yürüdükten sonra ikinci molayı veriyor.

Buna göre Fatma'nın okuluna ulaşması için kaç metre yolu kalmıştır?

A) 503 B) 513 C) 523 D) 533

17)

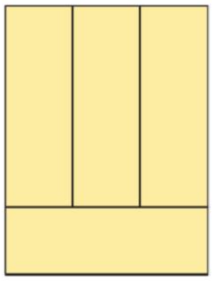


Şekilde ABCD dikdörtgeninin çevre uzunluğu, KLMN karesinin çevre uzunluğuna eşittir.

Buna göre KL uzunluğu kaç santimetredir?

A) 11 B) 12 C) 13 D) 14

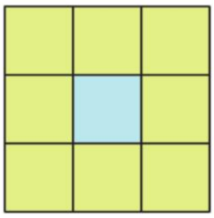
18)



Yukarıdaki eş dikdörtgenlerden oluşan şeklin bir tanesinin kısa kenar uzunluğu 4 cm ise tüm şeklin alanı kaç santimetrekaredir?

A) 192 B) 188 C) 184 D) 172

19)



Bir belediye bir arsayı eş karelere ayırarak ortasına havuz yapmayı planlıyor.

Havuzun çevresi 20 cm ise tüm arsanın alanı kaç cm^2 dir?

A) 180 B) 205 C) 215 D) 225

20)

7 dm + 40 mm = ... cm

Yukarıdaki boşluğa gelmesi gereken sayı kaçtır?

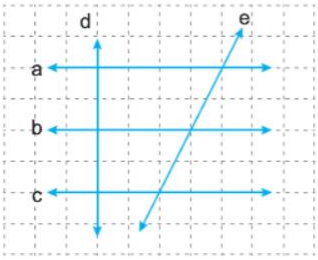
A) 47 B) 74 C) 470 D) 740

APPENDIX I

MATHEMATICS UNIT TEST

Name:

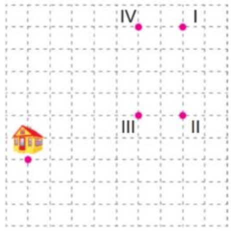
1)



Which of the following is correct according to the figure given on the square floor?

A) a ⊥ e B) b ⊥ d C) d ⊥ e D) a ⊥ c

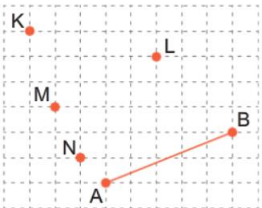
2)



The market is 6 units to the right of the house and 4 units above; It is 1 unit to the left of the school and 2 units above it.
Accordingly, in which of the places indicated by the number is the location of the school?

A) I B) II C) III D) IV

3)

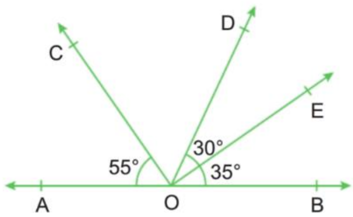


Which of the given points converge to form a line segment of equal length to segment AB?

A) K ile L B) L ile M

C) L ile N D) K ile N

4)

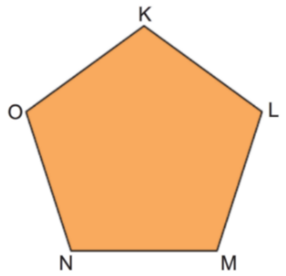


Angles A, O, and B in the figure are linear.

Accordingly, which of the following is incorrect?

A) DOB is an acute angle.
B) BOC is wide angle.
C) COE is a right angle.
D) AOE is a straight angle.

5)



How many diagonals are in the pentagon above?

A) 4 B) 5 C) 6 D) 7

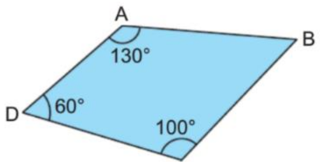
6)

-All diagonals are of equal length.
-The diagonals are equal in length.
-All interior angles are 90 degrees.

Which of the following is the quadrilateral shown above?

A) Parallelogram
B) Rhombus
C) Rectangle
D) Square

7)



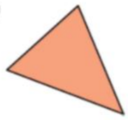
How many degrees is B relative to the quadrilateral above?

A) 50 C) 60 C) 70 D) 80

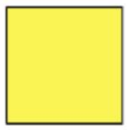
8)

Which of the following is not a polygon?

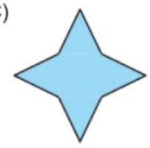
A)



B)



C)

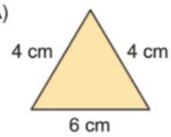


D)

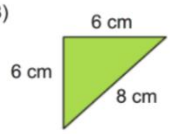
9)

Which of the following triangles is different from the others when classified by their sides?

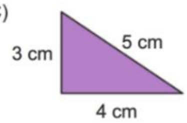
A)



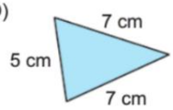
B)



C)



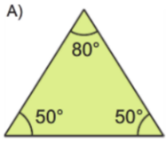
D)



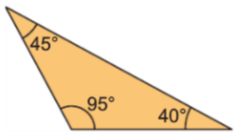
10)

Which of the following triangles is an obtuse triangle?

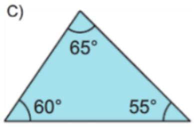
A)



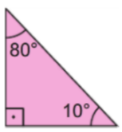
B)



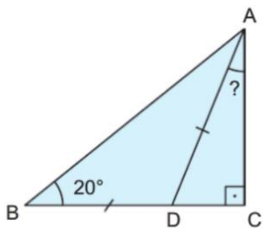
C)



D)



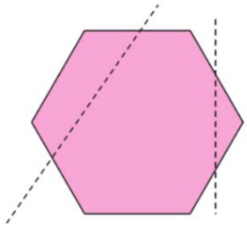
11)



According to the figure m(DAC)=?

A) 50 B) 60 C) 70 D) 80

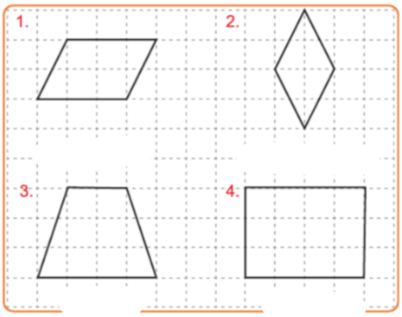
12)



Which of the following is the remaining piece of paper in the shape of an arrow shown above when it is cut from the marked places?

A) heptagon
B) Hexagon
C) Pentagon
D) quadrilateral

13)

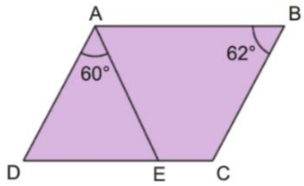


Which of the quadrilaterals listed above have the same diagonal lengths?

A) 1 ve 2 B) 2 ve 3

C) 3 ve 4 D) 1, 3 ve 4

14)



The parallelogram ABCD is given in the figure above.
How many degrees is m(AED)?

A) 58 B) 60 C) 62 D) 64

15)

7345 cm = ...I... m ....II... cm

Which of the following numbers should fit in the blank above?

	I	II
A)	73	45
B)	734	0,5
C)	734	5
D)	7300	45

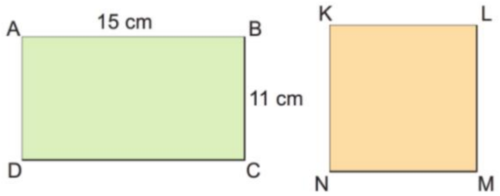
16)

Fatma sets out to go to her school, which is 5.7 km away. After walking 1760 m, he takes the first break, and after walking 3417 m, he takes the second break.

According to this, how many m does Fatma have to reach her school?

A) 503 B) 513 C) 523 D) 533

17)

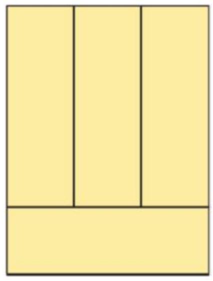


The perimeter of the rectangle ABCD above is equal to the perimeter of the square KLMN.

Accordingly, what is the length of KL in cm?

A) 11 B) 12 C) 13 D) 14

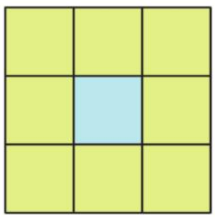
18)



If the short side length of one of the above congruent rectangles is 4 cm, what is the area of the whole shape, in square centimeters?

A) 192 B) 188 C) 184 D) 172

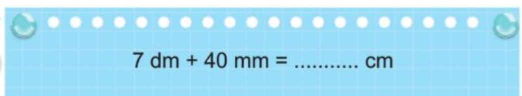
19)



The municipality wants to divide a field into equal squares and have a pool built in the middle.
If the circumference of the pond is 20 cm, what is the area of the entire field in square centimeters?

A) 180 B) 205 C) 215 D) 225

20)



What is the number that should go in the blank above?

A) 47 B) 74 C) 470 D) 740

APPENDIX J

FEEDBACK QUESTIONS (TURKISH)

Geçtiğimiz 5 hafta boyunca yaptığımız matematik ve bilişim teknolojileri derslerini nasıl buldun?

Bu derslerde Matematik konusunda ne öğrendin? Öğrendiğin 3 şeyi yazar mısın?

BT dersinde neler öğrendin? Öğrendiğin 3 şeyi yazar mısın?

Bu dersleri daha iyi anlaman için öğretmen nasıl yardımcı olabilir?

Bundan sonraki ünitelerde de Matematik ve BT derslerini ortak işleyelim mi? Neden?

APPENDIX K

FEEDBACK QUESTIONS

How did you find the Mathematics and ICT lessons we have been doing for the past 5 weeks?

What did you learn about Mathematics in these lessons? Can you write down 3 things you learned?

What did you learn in your IT class? Can you write down 3 things you learned?

How can the teacher help you to better understanding in these lessons?

Shall we study Mathematics and ICT lessons together in the next units? Why?

APPENDIX L

THE ACTIVITIES

Week	Lesson	Activity name	Is this a group work?	The tool	Where were the responses collected?	Learning environments	How many answers?	Math Objective	ICT Objective
1	ICT	Route of the Robot	YES	Drive	Drive	distance	5		Draws a flowchart for an algorithm. Uses word processing programs for online flowchart.
		Flowchart are entangled	YES	Wordwall		distance			Draws a flowchart for an algorithm. Debugs by testing an algorithm.
		What is the name of that polygon?	YES	Drive	Drive	distance	5	Names and creates polygons and recognizes their basic elements.	Draws a flowchart for an algorithm. Debugs by testing an algorithm.
	Math	Which one is a polygon?	YES	learningapps		distance		Names and creates polygons and recognizes their basic elements.	
		Tangram Algorithm	YES	Mathigon	Whatsapp	distance	8	Names and creates polygons and recognizes their basic elements.	

		Mystery of Diagonals-Part1	YES	Discussion		distance		Names and creates polygons and recognizes their basic elements.	
		Mystery of Diagonals	YES/NO	Geogebra	Whatsapp	distance	16	Names and creates polygons and recognizes their basic elements.	
		Mathematical Reflection	NO	Drive	Drive	distance			
2	ICT	Tangram	YES	Mathigon		distance	6		Solves a given problem using appropriate steps. Recognizes the steps to be followed in the problem-solving process.
		Variables	NO	learningapps		distance		Creates triangles according to their angles and sides, classifies the different triangles created according to their side and angle properties.	Explains the variables, constants and operations required to solve the problem.
	Math	Angles of the clock	YES	Drive, Geogebra	Whatsapp	distance	6	Creates triangles according to their angles and sides, classifies the different triangles created according to their side and angle properties.(Angles reminder activity)	
		Pitching the tent	NO	Geogebra	Whatsapp	distance	17	Creates triangles according to their angles and sides, classifies the different triangles created according to their side and angle properties.	

		Designing a slide	NO	Geogebra; Learningapps	Whatsapp	distance	14	Creates triangles according to their angles and sides, classifies the different triangles created according to their side and angle properties.	It offers solutions to the problems encountered in daily life. Solves a given problem using appropriate steps.
		Triangle Table	NO		Whatsapp	distance	17	Creates triangles according to their angles and sides, classifies the different triangles created according to their side and angle properties.	
		Mathematical Reflection	NO	drive; notebook	Drive; Whatsapp	distance	18		
3	ICT	The cups	YES	bilgeBT	Whatsapp	distance	5		Solves a given problem using appropriate steps. Analyzes a given problem.
		Creating Polygons	YES	EBA	Whatsapp	distance	7	Identify and draw the basic elements of rectangle, parallelogram, rhombus and trapezoid.	Solves a given problem using appropriate steps. (It is emphasized that different algorithms can be designed to solve a problem.)
	Math	The quadrilateral family	YES	Geogebra; drive; Padlet	drive	distance	4	Identify and draw the basic elements of rectangle, parallelogram, rhombus and trapezoid.	
		The sitting arrangement	NO	geogebra		distance		Identify and draw the basic elements of rectangle, parallelogram, rhombus and trapezoid.	

		Code.org Quadrilateral design	NO	codeorg	Whatsapp	distance	12	Identify and draw the basic elements of rectangle, parallelogram, rhombus and trapezoid.	Recognizes the interface and features of the block-based programming tool.
		Mathematical Reflection	NO	drive	Drive	distance	15		
4	ICT	Blockly introduction	NO	PPT		Face-to-face			Recognizes the interface and features of the block-based programming tool.
		Blockly Puzzle	NO	blockly		Face-to-face			It creates the right algorithm to achieve the goals presented in the block-based programming environment.
		Hungry bird	NO	blockly		distance		Reminding the perigon angle is 360 degrees.	It creates the right algorithm to achieve the goals presented in the block-based programming environment. Develops algorithms including decision structures.
	Math	Triple Triangles	YES			Face-to-face		Determines the sum of the measures of the interior angles of triangles and quadrilaterals and finds the missing angle.	
		From triangles to quadrilaterals	YES			distance		Determines the sum of the measures of the interior angles of triangles and quadrilaterals and	

								finds the missing angle.	
		The wooden frame	YES	blockly	whatsapp	distance	7	Determines the sum of the measures of the interior angles of triangles and quadrilaterals and finds the missing angle.	Develops algorithms including decision structures. Creates algorithms with loop structure.
		Mathematical Reflection	NO	drive	Drive	distance	21		
5	ICT	Distances in the maze	NO	blockly	Whatsapp	distance	18	Recognizes the units of length measurement; Converts meter-kilometer, meter-decimeter-centimeter-millimeter units and solves related problems.	
	Math	Metric conversion	NO			Face-to-face		Recognizes the units of length measurement	
		Thee wooden frame- Cont.	YES			distance	17	Converts meter-kilometer, meter-decimeter-centimeter-millimeter units and solves related problems.	
		Race in the school background	YES			Face-to-face	24	Calculates the perimeters of triangles and quadrilaterals	
		Mathematical Reflection	NO	drive	Drive	distance	17		

APPENDIX M

STUDENTS ARTIFACTS FOR ALL PARTICIPANTS

	week 1		week 2		week 3		week 4		week 5	
	Name of the polygon		Designing a slide		Code.org Quadrilateral Design		Wooden Frame		Distances in the maze	
	math	ICT	math	ICT	math	ICT	math	ICT	math	ICT
Zehra	10	8	4	3	10	8	8	10	10	6
Ali	5	0	0	0	5	5	3	4	5	3
Nida	4	3	4	0	5	5	6	5	5	6
Betül	0	0	4	0	5	8	6	4	7	5
Mehmet	2	3	0	0	5	5	8	6	8	5
Merve	10	6	7	8	10	8	8	6	9	8
Dila	10	6	7	6	8	5	8	5	8	8
Faruk	5	3	7	6	8	10	6	6	10	8
Melisa	10	8	8	8	10	10	10	6	10	8
Burak	5	6	7	3	10	8	10	6	9	10
Ayşe	10	8	8	8	10	10	10	10	10	8
Esin	6	3	4	6	5	5	6	6	5	6
Ekin	5	3	5	6	5	8	8	6	6	6

Rıza	0	0	-	-	5	5	3	4	6	5
Yusuf	10		3	0	5	5	6	4	6	6
Bahar	5	3	7	3	10	10	8	8	8	8
Eylül	0	3	8	3	5	5	6	6	6	6
Yasin	-	-	0	0	0	0	0	0	2	3
Ömer	-	-	3	3	5	5	6	4	6	5
Osman	0	0	0	3	-	-	-	-	6	5
Kerim	5	3	3	3	10	5	6	4	8	6
Hasan	6	3	8	6	10	8	10	8	8	8
Gökhan	0	0	4	3	10	5	8	6	8	6

APPENDIX N

WEEKLY ASSESSMENTS -MATHEMATICAL REFLECTION

	week 1		week 2		week 3			week 4			week 5		
	Q1	**Q2**	**Q1**	**Q2**	**Q1**	**Q2**	**Q3**	**Q1**	**Q2**	**Q3**	**Q1**	**Q2**	**Q3**
Zehra	1	1	0	0	2	2	2	2	2	2	2	0	2
Ali	0	0	0	0	0	0	0	2	2	0	2	0	0
Nida	0	0	0	0	0	2	0	0	2	0	2	0	1
Betül	0	0	0	0	0	0	0	2	2	2	0	0	0
Mehmet	0	0	0	0	0	0	0	2	2	2	0	2	1
Merve	1	2	2	2	0	2	0	2	2	0	2	2	1
Dila	1	2	2	2	1	2	0	2	2	0	2	2	1
Faruk	1	1	1	1	1	2	2	2	2	2	2	2	0
Melisa	1	1	2	2	1	2	2	2	2	2	2	2	2
Burak	0	0	0	1	0	0	0	2	2	2	2	0	1
Ayşe	2	0	2	2	2	2	0	2	2	2	2	2	2
Esin	1	0	2	2	0	2	0	2	2	0	2	0	0
Ekin	1	1	1	1	2	2	0	2	2	0	2	2	1
Rıza	0	0	0	0	0	0	0	0	0	0	0	0	0
Yusuf	1	0	2	1	1	2	0	2	2	2	2	0	0
Bahar	1	0	1	1	0	2	0	2	2	2	2	2	0
Eylül	0	0	0	0	0	0	0	0	0	0	0	0	0

Yasin	0	0	0	0	0	0	0	0	0	0	0	0	0
Ömer	0	0	0	0	0	0	0	0	0	0	0	0	0
Osman	0	0	0	0	0	0	0	0	0	0	2	2	1
Kerim	0	0	0	0	0	0	0	0	0	0	0	0	0
Hasan	1	2	2	2	1	2	2	2	2	2	2	2	1
Gökhan	0	0	0	0	2	0	0	0	0	2	2	0	0

APPENDIX O

LESSON PLANS (TURKISH)

Hafta 1

Kazanımlar:

5.5.1.15. Bir algoritma için akış şeması çizer.

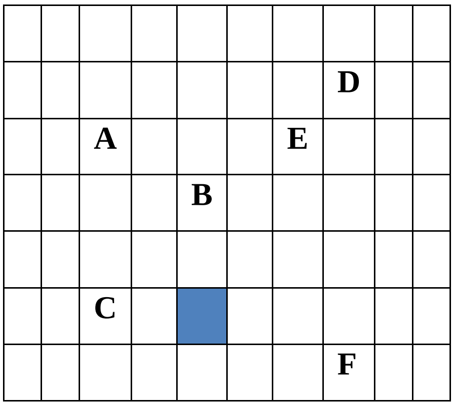
Akış şemasının elektronik ortamdaki çizimi için kelime işlemci programları veya diğer çizim programları kullandırılır.

5.5.1.16. Bir algoritmayı test ederek hataları ayıklar.

Robot'un rotası

Derste öğrencilerin önceki hafta kullandıkları robotun belirtilen hedefe gitmesi için oluşturdukları akış şemasını geliştirmeleri beklenmektedir. Aşağıdaki problem öğrencilere sunulur.

Problem 1.1: Robotun hareket edeceği yeni platform aşağıdaki görselde verilmiştir, mavi bölge robotun bulunduğu yeri temsil etmektedir.



Robotumuz A noktasına gitmek istiyor, fakat oraya giderken diğer noktaların olduğu kutucuklara girmemesi gerekiyor. Robotun takip edebilmesi için bir akış şeması hazırlayabilir misiniz?

Öğrencilerle aşağıdaki sorular sorulur:

- *"A noktasının Robot'a göre konumu nedir?"*
- *"B noktasının Robot'a göre konumu nedir?"*
- *"A noktasının B noktasına göre konumu nedir?"*

- *"Robot A noktasına en kısa yoldan giderken B'den geçmek zorunda mı?"*

Sınıf olarak bu soruları cevapladıktan sonra, öğrencileri 3-4 kişilik gruplara ayırarak problemi çözmeleri istenir. Akış şemalarını oluşturabilmeleri için gruplara aşağıdaki link verilir:

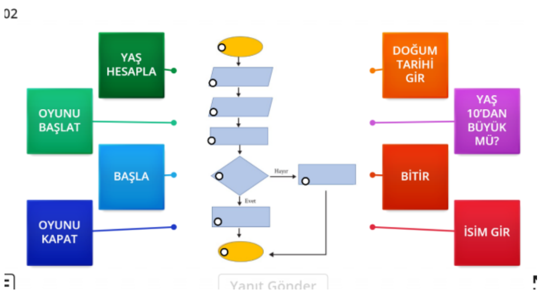
https://docs.google.com/drawings/d/1ivmKxk-AT5y-4t_AJcuUG-skPzqE5qC0-j4x9bVlSyQ/edit?usp=sharing

Her grup için ayrı sayfalar oluşturulur, grup üyelerinden bir tanesi ekranını paylaşarak sayfadaki akış şeması elemanlarını sıralamasını arkadaşlarıyla beraber yapar. Aktivitenin sonunda gruplar birleşir, öğretmen kendi ekranında her grubun oluşturduğu algoritmaya göre robotun rotasını çizerek robotu hedefe ulaştırır.

Eyvah Akış Şemaları Karışmış

Aşağıdaki senaryolar öğrencilere okunur ve bu senaryolara uygun akış şemasının çizilmesi istenir. Akış şemasını çizebilmeleri için: https://wordwall.net/tr/resource/14287048/ak%c4%b1%c5%9f-%c5%9femalar%c4%b1-kar%c4%b1%c5%9fm%c4%b1%c5%9f-senaryo-3 linki kullanılır. Aşağıdaki görselde bu linkten bir örnek bulunmaktadır.

Öğrenciler 3 kişilik gruplara ayrılır, her gruba bir senaryo atanır. Bir kişi ekran paylaşımı yaparak linke girer, iki kişi de senaryoyu açarak adım adım okumayı yapar ve grupça akış şemasının adımlarına karar verilir.



<u>Senaryolar:</u>

Senaryo 1: Alperen 8. sınıfa giden bir öğrencidir. Alperen'in annesi sadece cumartesi akşamı 23.00'te uyumasına izin vermekte diğer günlerde ise 21.00'de uyumasını istemektedir. Alperen cep telefonuna uyku saatini hatırlatması için bir hatırlatıcı eklemiştir. Bu hatırlatıcının çalışmasına ait akış şemasını oluşturunuz.

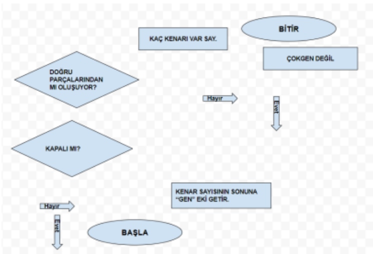
Senaryo 2: Nilüfer babasıyla birlikte bindiği asansörde 'Max. 250 kg' yazısını okumuş ve babasına bunun ne anlama geldiğini sormuştur. Babası asansörün en fazla 250 kg yük taşıyabildiğini, asansörde 250 kg'dan fazla ağırlık olduğunda ise çalışmadığını belirtmiştir. Siz de asansörün çalışma biçimini anlatan bir akış şeması oluşturunuz.

Senaryo 3: Ahmet Bey oğlu Mert'e oynaması için bir bilgisayar oyunu almıştır. Bilgisayar oyununun üzerinde 10 yaş ve üzeri yazmaktadır. Mert 11 yaşında olduğu için oyunu bilgisayarına kurarak oynamaya başlar. Mert'in 8 yaşındaki kardeşi Efe de oyunu merak eder ve abisinin evde olmadığı bir zamanda oyunu açmak ister. Ancak oyun başlamadan önce çıkan ekranda Efe adını ve doğum tarihini yazmak zorundadır. Efe bu bilgileri girer ancak oyun bir türlü başlamaz. Sizce bilgisayar bu durum için nasıl bir akış şeması kullanmıştır?

Çokgenin adı ne?

Öğrencilere çokgenlerin isimlendirirken bir karar verme süreci olduğunu ve bu süreci kendilerinin düzenlemeleri söylenir.**(ICT (10p): algoritma 3p, doğru akış şeması 5p, online çizim prog kullanımı 2p. Math(10p): mathematical info in the flowchart 5p, tablo 5p)**

https://docs.google.com/drawings/d/1eiWMQ7o1txv2E5SXdtX7bu3V7O_9GoUgdubJBE2DLvo/edit



Linkteki akış şeması düzenlendikten sonra öğrencilere söz hakkı tanınarak aşağıdaki tablo doldurulur. (5p)

Şekil	Kenar sayısı	Çokgenin ismi

Ne öğrendik?

Dersin sonunda öğrencilere akış şemalarının nerelerde kullanılabileceği sorulur? Matematik ile olan ilişki vurgulanır. Diğer bilimsel süreçlerde akış şemalarının kullanımına örnek verilir.

Hafta 2

Kazanımlar:

5.5.1.1. Günlük hayatta karşılaştığı problemlere çözüm önerileri getirir.

5.5.1.2. Verilen bir problemi uygun adımları kullanarak çözer.

Bir problemi çözmek için farklı algoritmalar tasarlanabileceği vurgulanır.

5.5.1.4. Problem çözme sürecinde takip edilmesi gereken adımları fark eder.

5.5.1.5. Verilen bir problemi analiz eder.

5.5.1.6. Problemi çözmek için gerekli değişken, sabit ve işlemleri açıklar.

Tangram

Tangram aktivitesini kullanmak için https://tr.mathigon.org/tangram linki kullanılacaktır.

Etkinliğe girişte gruplara ayırmadan önce öğretmen ekran paylaşımı yaparak tangram parçalarının nasıl hareket ettirileceğini gösterir. Ardından aşağıdaki görseldeki gibi bir tane klasik tangram şekli oluşturulur ve öğrencilerin uygulamaya aşinalık oluşturulmaya çalışılır.

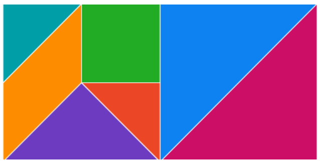
Uygulama tanıtıldıktan sonra öğrenciler dörder kişilik gruplara ayrılır ve gruptakilerin görevlerini anlatır.

<u>Grup üyelerinin görevleri:</u>

- 1 kişi link ile uygulamaya girerek ekran paylaşımı yapar.

- 2 kişi öğretmenin göstereceği şekli grup arkadaşına tarif eder, hangi parçayı nereye koyması gerektiğini ve ne kadar döndürmesi gerektiğini anlatır. *(Yeterli öğrenci olmaması durumunda 1 kişi olabilir.)*
- 1 kişi ise bu tarif edilme sürecinin akış şemasını yazar.

Öğrenciler gruplara ayrıldıktan sonra şeklin gösterileceği üyelere aşağıdaki görsel sunulur ve 1 dakika süre verilir şekli incelemeleri için sonrasında arkadaşlarının yanına gönderilirler.



Arkadaşlarına bu şekli tarif etmeleri ve grubun akış şemasını hazırlaması için 10 dakika süre verilecektir.

Öğretmen bu süre içerisinde gruplara destek olur. Bütün gruplar zamanlarını doldurduğunda sınıf toplanır ve her grup kendi akış şemasını öğretmene gösterir, öğretmen her akış şemasını kendisi uygulayarak kontrol eder.

Etkinliğin sonunda basit bir geometrik şekil için birbirinden farklı akış şemalarının oluşabileceği vurgusu yapılır. Daha karmaşık şekillerde bu akış şemalarının da gelişeceğinden ve karmaşıklaşacağından bahsedilir.

Değişkenler

Kılavuz kitapta verilen “Zarftaki Değişkenler” etkinliğindeki şiir girişi kullanılır.

Sınıftan birkaç kişinin ismiyle aşağıdaki şiir okunur:

Mete gözlerini açmış

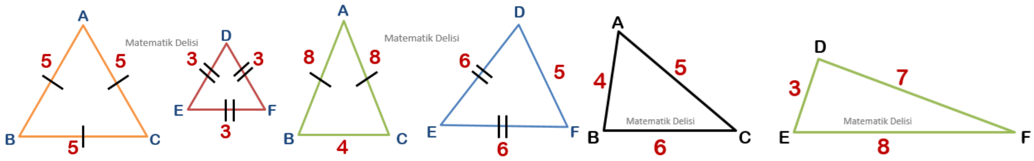
Gönlüne güneş kaçmış

….

Furkan gözlerini açmış

Gönlüne güneş kaçmış

Bunu bütün sınıf için yapmanın çok uzu süreceğine dikkat çekilir. Sonrasında aşağıdaki örnek üçgenler gösterilir.



Her üçgeni belirtmek için kenar uzunlukları yazılır (5-5-5 üçgeni; 3-3-3 üçgeni vb.). Öğrencilere aşağıdaki açıklama yapılır:

"Bu şekilde karşımıza çıkan bütün üçgenleri tanımlamaya çalışmak sınıftaki herkesin ismiyle aynı şiiri yazmaya çalışmak kadar zor. Bu yüzden verilen örneklerde neyin değiştiğine dikkat ederek belki daha kolay bir yol bulunabilir."

Öğretmen şiirlerdeki isimleri yuvarlak içine alıp "ad" yazar. Buradaki ad yazılı yere herhangi başka bir ad yazılırsa şiirde sorun olmayacağını söyler. Birkaç tane deneme yapar. *"Ad yerine 'yaş' yazsaydık şiirimiz yine doğru olur muydu?"* diye sorduktan sonra birkaç öğrencinin yaşı sorulur ve şiirde yerine yazılır. Bunu doğru bir yer tutucu olmadığı gösterilir.

https://learningapps.org/display?v=pxtrm2hqt20 linki açılır ve ekran paylaşılır, öğrenciler değişkenleri doğru yer tutucularla eşleştirir.

Üçgen görselleri tekrar açılır ve aynı şekilde bir "yer tutucu" bu üçgenler için de verilebilir mi tartışılır. Öğrencilerden kenarlarına göre bu üçgenleri sınıflandırılabileceği fikrinin gelmesi beklenir. Üçgen kenarlarının birbirlerinden farkının ve benzerliklerinin ne olduğu sorularak "çeşitkenar, eşkenar, ikizkenar" isimlerine ulaşmaları için sorular sorularak yönlendirmeler yapılır.

Hafta 3

Kazanımlar:

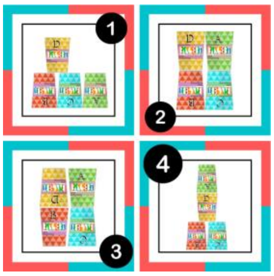
5.5.1.2. Verilen bir problemi uygun adımları kullanarak çözer.

5.5.1.5. Verilen bir problemi analiz eder.

5.5.2.2. Blok tabanlı programlama aracının arayüzünü ve özelliklerini tanır.

Bardak Etkinliği

Bilişim Teknolojileri ve Yazılım kılavuzunda yer alan "Hikaye Yazıyorum-Programlamaya Başlıyorum" başlıklı etkinlik öğrencilerle yapılacaktır. Uzaktan eğitim için bazı değişiklikler yapılmıştır. Etkinlik süresince https://bilgebt.com/2021/04/23/d2-11-hafta-5-sinif-hikaye-yaziyorum/ adresi kullanılacaktır. Öğrenciler 4-5 kişilik gruplara ayrılır, bir kişi verilen linki açar ve ekran paylaşımı yapar, bir kişi yapılması gereken adımları defterine not alır, diğerleri yapılacak adımları söyler. Aşağıda bilgeBT sayfasındaki etkinlikten ekran görüntüleri bulunmaktadır. İlki öğretmen tarafından adım adım yazılarak öğrencilere etkinlikten beklentinin ne olduğu gösterilmiş olur. Sırasıyla diğer bardak düzenlerinin öğrenciler tarafından hazırlanması istenir.



Öğrenciler bütün bardak düzenlerini hazırladıktan sonra sınıf toplanır, öğretmen her gruptan süre yettiği kadar sıralama adımlarını dinler ve kendi ekranını paylaşarak doğru gösterimlere örnekler verir. **(bardakların doğru konumlanması için 6p, algoritma yazımı için 4p)**

Çokgen oluşturma

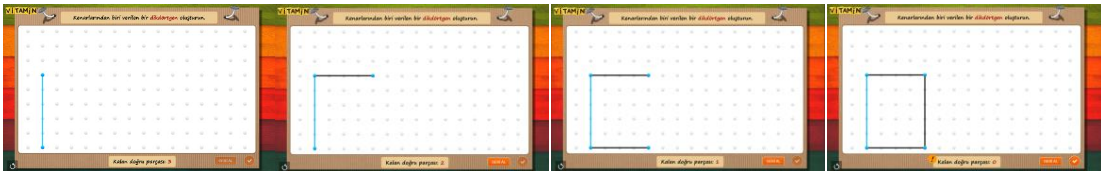
Öğrenciler 2 kişilik gruplar oluşturur. Aşağıdaki linkten ekran görüntüsü verilen etkinliği yapmaları beklenmektedir.

https://ders.eba.gov.tr/ders//redirectContent.jsp?resourceId=f06538f5249552c452d239bb1b77f3a5&resourceType=1&resourceLocation=2

Bu etkinlikte, gruptaki öğrencilerden biri ekran paylaşımı yapar diğeri ise etkinlikte istenen dörtgeni yapabilmeleri için her adımda hangi noktadan geçen doğru parçası çizmeleri gerektiğini söyler. Dikdörtgen, paralelkenar ve yamuk içi birden fazla alternatif olması doğru çözümün tek olmadığı konusunda da öğrencilere yol göstermiş olur.

Aşağıda etkinlikten önce öğrencilere örnek olarak gösterilecek bir sıralama verilmiştir.

- Üst nokta ve 4 br sağındaki noktadan geçen doğru parçası
- Alt nokta ve 4 br sağındaki noktadan geçen doğru parçası
- İlk iki adımda oluşturulan noktaları birleştiren doğru parçası çizilir.



Hafta 4

Kazanımlar:

5.5.2.1. Programlamayla ilgili temel kavramları açıklar.

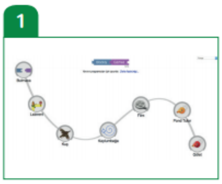
5.5.2.2. Blok tabanlı programlama aracının ara yüzünü ve özelliklerini tanır.

5.5.2.3. Blok tabanlı programlama ortamında sunulan hedeflere ulaşmak için doğru algoritmayı oluşturur.

5.5.2.7. Karar yapılarını içeren algoritmalar geliştirir.

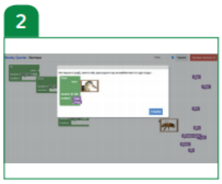
Blockly tanıtım (10 dk)

Bilişim Teknolojileri ve Yazılım dersi kılavuz kitaptaki aşağıdaki Blockly tanıtım sunumu yapılır.



Tüm oyun ikonlarının bulunduğu site giriş ekranı gösterilerek şu açıklama yapılır:

"Blockly Oyunlar, bilgisayar programlama konusunda daha önce deneyimi olmayan çocuklara, programlama eğitimi vermek üzere hazırlanmış, eğitici oyunlardır."

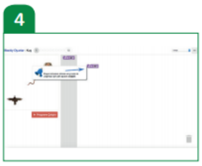


Daha sonra Bulmaca oyun ekranı açılarak şu açıklama yapılır:

"Bulmaca oyununu Blockly Oyunlar'daki temel şekilleri öğrenmek ve blok tabanlı işlemlere giriş için kullanacağız"

Labirent oyun ekranı açılarak şu açıklama yapılır:

"Labirent oyununda karakterimizi hedefe ulaştırarak komut verme, döngü ve karar işlemlerine giriş yapacağız, ama her seviyede işimiz biraz daha zorlaşacak."

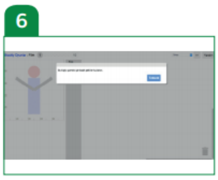


Kuş oyun ekranı açılarak şu açıklama yapılır:

"Kuş oyununu oynarken karar verme problemimiz zorlaşacak ama çok eğleneceğiz."

Kaplumbağa oyun ekranı açılarak şu açıklama yapılır:

"Şekiller çizmeye çalışan küçük kaplumbağamıza döngüler oluşturarak yardımda olmaya çalışacağız."

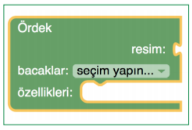


Film oyun ekranı açılarak şu açıklama yapılır:

"Biraz matematik ve programlamayı birleştirerek, resim ve animasyon oluşturacağız, çok zevkli olacağına eminim."

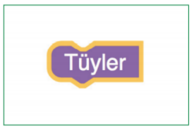
Blockly Bulmaca (20 dk)

Blockly sayfasındaki ilk etkinlik olan Bulmaca sayfası açılır, BTY kılavuz kitapta da belirtilen aşağıdaki blok tanıtımları yapılır. Öğrenciler Code.org sayfasında daha önce çalıştıkları için blok tabanlı programlara aşinalar. Bu sayfada gösterilen yönergeler doğrultusunda blokların taşınacağından bahsedilir ve kedi örneği yapılarak öğrencilere gösterilir.



Yeşil Blok: Diğer blokların birleştirileceği ana bloktur, hayvan resmi, resim bölümüne gelecek, bacaklar menüsünden seçim yapılacak ve özellik kısmına mor özellik bloklarından uygun olan eklenecektir.

Hayvan Resimli Bloklar: Yeşil bloklara eklenecek resim parçalarının bulunduğu bloklardır.



Mor Bloklar: Hayvanların özelliklerinin bulunduğu bloklardır. Yeşil bloklar üzerinde doğru yerlere yerleştirilmeleri gerekir.

Ardından öğrenciler https://blockly.games/puzzle?lang=tr sayfasına girerek bireysel olarak diğer hayvanların bulmacasını çözerler. Dersin son 5 dakikasında bütün sınıf toplanır, öğretmen kendi ekranında doğru çözümleri gösterir, sorular varsa alır ve dersi bitirir.

Kuş yem arıyor (30 dk)

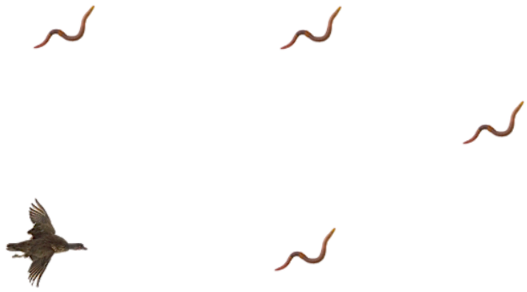
Matematik dersinde kaplumbağa etkinliğini kullanarak çeşitli dörtgenler oluşturulması isteneceği için blockly üzerinden açıların iyi kavranması amacıyla "Kuş" etkinliğinin ilk 3 aşaması yapılacaktır.

Aşağıdaki görselde görüldüğü gibi öğretmen öğrencilere bu saat üzerinden açıları hatırlamak amacıyla bir tur için kaç derecelik dönme yapılması gerektiğini sorar. Böylece tam açıdan bahsedilir; ardından, doğru açı, dik açı, dar açı ve geniş açı kavramları tek tek sorularak ve ardından saat üzerinden gösterilerek hatırlatılır.

Ardından https://blockly.games/bird?lang=tr linki öğrenciler ile paylaşılır ve ilk aşamayı yapmaları için en fazla 5 dk süre verilir. 5 dk sonra sınıf toplanır öğretmen kendi ekranını paylaşarak doğru cevabı açar. ***(ICT: 4p)***

Ardından öğretmen öğrencilere aşağıdaki görseli gösterir ve şu soruyu sorar:

Aşağıdaki kuş çok aç ve çevresindeki 4 solucanı da <u>en az adımda</u> yemek istiyor. Bunun için nasıl bir rota izlemesi gerekir? Dönme açılarıyla beraber adım adım rotasını yazabilir misiniz? **(math:10p/ 2.5p for each correct angle, ICT:4p/ 2p for writing each step correctly and 2p for requiring the minimum step condition)**



Öğrenciler 2-3 kişilik gruplara ayrılır ve rotayı oluşturmaya çalışırlar. Öğretmen bu sırada grupları dolaşarak destek gerektiğinde yardımcı olur. En fazla 10 dk süre verildikten sonra sınıf toplanır. Grupların bulduğu rotalar tek tek dinlenir. Farklı rotalar çizilmiş olacaktır, bu rotalar öğretmen tarafından da görsel üzerinde gösterilir ve adım adım yazılır.

Ardından https://blockly.games/bird?lang=tr *ikinci aşamayı öğretmen ekran paylaşımı yaparak tanıtır, "eğer" yapısı anlatılır ve nasıl çalıştığı gösterilir. Öğrencilere link tekrar gönderilir, ikinci ve üçüncü aşamaları bireysel olarak tamamlamaları istenir. Dersin son birkaç dakikasında sınıf toplanır öğretmen üçüncü aşamanın da cevabını gösterir ve dersi bitirir.* ***(ICT:2p for the if condition)***

Matematik

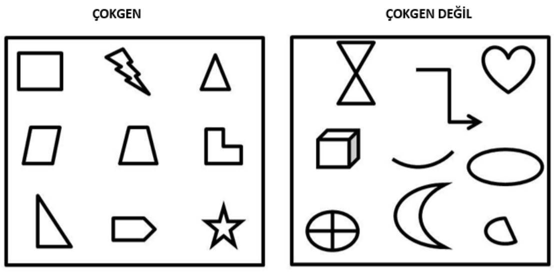
Hafta 1

Kazanımlar: Çokgenleri isimlendirir, oluşturur ve temel elemanlarını tanır.

Hangisi çokgen? (20 min)

Öğrencilere aşağıdaki çokgen olan ve olmayan şekiller tablosu sunulur. Buradaki ayrımın hangi kritere göre yapıldığı üzerine konuşulur.

Not: BT dersinde çokgen olma şartlarıyla ilgili ders yapılmış olmalı



Ardından https://learningapps.org/19446323 linki açılır (aşağıda linkten ekran görüntüsü bulunmaktadır) ve bu etkinlikte öğrencilerin karşılarına çıkan şekilleri çokgen olup olmama durumuna göre uygun tarafa sürüklemeleri gerektiği ifade edilir.

Öğrenciler 3-4 kişilik gruplara ayırılır, bir kişinin ekran paylaşımı yapması sağlanarak grupça bu sürükle bırak etkinliğini yapmaları beklenmektedir.

Tangram Algoritması (30 min)

Tangram parçaları tanıtılır, bu parçaların birleşerek bir kare oluşturdukları gösterilir. Bazı parçaları kullanarak farklı geometrik şekiller oluşturulabildiğinden bahsedilir. Örneğin, iki tane üçgeni farklı konumlandırarak dörtgenler oluşturulur.

Sonrasında aşağıdaki şekiller gösterilir ve https://tr.mathigon.org/tangram adresinde bu şekillerin nasıl oluşturulduğu gösterilir. Bu aşamada çokgenlerin isimleri söylenilmez.

Ardından yine https://tr.mathigon.org/tangram linki paylaşılarak öğrencilerden örnekte gösterildiği gibi tangram parçalarını birleştirerek birbirinden farklı en az 2 şekil yapmaları söylenir. 2-3 kişilik gruplar oluşturulur, gruptan bir kişi ekranını paylaşır ve arkadaşlarıyla beraber çalışır. Her gruptan yaptıkları şekillerin ekran görüntülerini almaları istenir.

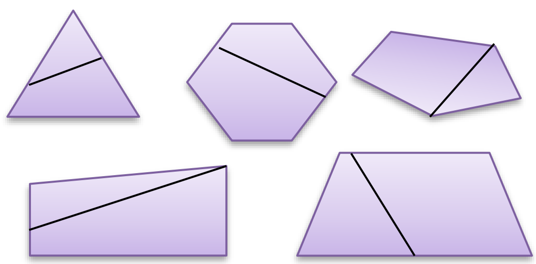
Gruplar şekillerini yaptıktan sonra sınıf toplanır, her gruba hangi şekilleri yaptıkları sorulur, öğrenciler şekillerini gösterirler. Öğretmen birkaç grubun şekillerine baktıktan sonra aşağıdaki soruyu yöneltir:

"Sizce hepsine tek tek bakmamız uzun sürmez mi? Bu şekilleri göstermek yerine isimlerini söylesek daha kolay olabilir, ne dersiniz?"

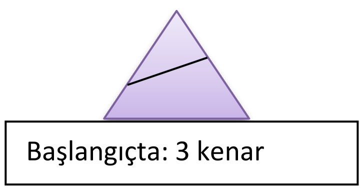
Böylece yapılan şekillere isim verilmesi kararlaştırılır ve kenar sayısına göre isim verilebileceğinden bahsedilir. Öğretmen Resim3'teki görselleri açar ve kenar sayısının sonuna "-gen" eki getirerek çokgenleri isimlendirir. Aynı isimlendirme stratejisini öğrencilerin uygulamasını sağlar. **(math (10p) çokgen oluşturma 5p; oluşan çokgeni isimlendirirken köşe sayısının sonuna gen eki getirerek ismini söyleme 5p)**

Köşegen Sayısının Gizemi- Bölüm 1 (20 min)

Aşağıdaki çokgen görselleri öğrencilere gösterilir. Bu çokgenlerin siyah doğru parçalarından kesildiği taktirde oluşan yeni çokgenlerin kaç kenarı olabileceği öğrencilere sorulur.



Örnek:



Öğrencilerle birlikte örnekte gösterildiği gibi kenar sayıları belirlendikten sonra yeni oluşan şekildeki kenar sayısının şeklin neresinden kestiğimizle bir ilişkisi olup olmadığı sorulur ve öğrenciler 4'er kişilik gruplara ayırılarak grupça bunu tartışmaları istenir.

Gruplar tekrar toplandığında yorumlar dinlenir ve öğrencilerden köşelerden kesmenin diğerlerinden daha az kenar sayısına sebep olması yönünde cevaplar alınması beklenir. Bu çıkarıma ulaşamamışlarsa birkaç örnek daha gösterilerek ulaşmaları için ek sorular sorulabilir. *("Sence şekli ikiye kestiğimizde her seferinde iki katı kadar mı kenar olur?" "Bazılarında başlangıçta 4 kenarlıyken kesince iki katından daha az kenarı olmuş, sence neden?")*

Köşeden köşeye kesildiğinde kesme yerlerinden hep daha az kenar sayılı olduğu fark edilince *"Bu kesen doğru parçasının özel bir ismi var sizce ne isim verilmiş olabilir?"* diyerek köşegen ismine ulaşmaları beklenir. Yardım olarak çokgenlerde "-gen" ekinin popüler olduğu hatırlatılır.

Köşegen sayısının gizemi (60 min)

Aşağıdaki problemler doğrultusunda ders işlenir.

Soru 1 öğrencilere sunulduktan sonra verilen link kullanılarak çokgen çizmek için kullanılan sayfada bir örnek yapılır. Öğrenciler bireysel olarak şekillerini çizer. Birkaç öğrenciden ekran paylaşımı yaparak çizdikleri altıgenleri göstermeleri beklenir.

Soru 2'deki tablonun ilk iki satırı için öğretmen web sayfasında çokgenleri çizer ve köşegenleri belirtir, tablo da sınıfça doldurulur. Diğer satırları doldurmaları için öğrenciler 4-5 kişilik gruplara ayrılırlar, tablodaki satırları doldurduktan sonra sınıf toplanır ve öğretmen dolu bir tabloyu paylaşır. Kenar ve köşegen sayıları ilişkisini tartışmaları için eğer öğrenciler vakte ihtiyaç duyarsa yeniden gruplara ayrılırlar.

Köşegen ve kenar sayıları arasındaki ilişki belirtildikten sonra Soru 3 için öğrencilere vakit verilir. Ders sonunda köşegenin ne demek olduğu, bir çokgendeki köşegen sayısının nasıl bulunabileceği üzerine konuşulur.

Sorular:

1. 5.sınıf öğrencisi Aslı defterine altıgen (6 kenarı olan bir çokgen) çizmiş ve bu çokgendeki bütün köşegenleri de belirlemiştir. Aslı kaç tane köşegen çizmiştir? Şekil çizerek gösteriniz. https://www.geogebra.org/m/j8etmmwh buradan faydalanarak çizebilirsiniz. **(3p)**

2. Öğretmeni Aslı'ya hangi çokgeni çizerse çizsin köşegen miktarını bilebileceğini söyler. Bunu nasıl yaptığını anlamak için Aslı da yedigen ve sekizgen çizmiş ve bu şekillerin de köşegenlerini belirlemiş. Şekillerin kenar sayıları ve köşegenleri arasında bir ilişki var mı diye bakmak için bir tablo çizmiştir. Aşağıdaki tabloyu doldurarak siz de ilişkiyi aramasına yardımcı olunuz.

Kenar Sayısı	Köşegen Sayısı
6	
7	
8	

Kenar ve köşegen sayıları arasında bir ilişki buldunuz mu? Açıklayınız. **(4p)**

3. Aslı'nın sınıf arkadaşı Burak bir şekil çizdiğini ve bu şeklin köşegen sayısının 5 olduğunu söylüyor, fakat Aslı bunun imkânsız olduğunu iddia ediyor. Sizce Aslı haklı olabilir mi? Neden? **(3p)**

Mathematical Reflections (10 min)

https://forms.gle/wN1LKwKRyk5zEYeA9 adresinde bu hafta öğrendiklerini yansıtmaları için 2 adet soru bulunmaktadır. Haftanın son dersinde bu formu doldurmaları beklenir, öğrencilerin hepsi cevaplarını gönderince kısaca sorulara cevap verilir ve ders sonlandırılır.

Hafta 2

Kazanımlar:

M.5.2.2.2. Açılarına ve kenarlarına göre üçgenler oluşturur, oluşturulmuş farklı üçgenleri kenar ve açı özelliklerine göre sınıflandırır.

Saatteki Açılar (30 min)

Bu etkinlik süresince https://cutt.ly/ovCd4IW ve https://www.geogebra.org/m/dfwwz8cu adresleri kullanılacaktır. Öğrencilere aşağıdaki problem sunulur. Ardından ilk internet adresi paylaşılarak öğrenciler 3-4 kişilik gruplara ayrılır ve soruya cevap vermeleri beklenir.

Aslı arkadaşı Burak'a bir bilmece sorar: Akrep ve yelkovan 90 derecelik açı yapıyor ve yelkovan 3 rakamının üzerinde. Fakat akrep 12 üzerinde değilse saat kaçtır?

Burak doğru cevaba ulaştığına göre saatin kaç olduğunu söylemiştir? **(math: 5p)**

Öğrencilerden gelen cevaplar kontrol edilir ve 90 derece yani dik açı kavramı hatırlatılır. Geniş ve dar açıları da tekrar etmek amacıyla aşağıdaki soru öğrencilerle paylaşılır.

Burak'ın hızlıca doğru yanıta ulaştığını gören Aslı işleri biraz daha karmaşıklaştırmak için bir hafta sonu planının bir kısmını içeren aşağıdaki tabloyu hazırlar.

Saat	Etkinlik
9.30	Kahvaltı
11.00	Ödevlere başlama
12.15	Çizgi dizi izleme
13.15	Kitap okuma
14.35	Arkadaşlarla kamp için buluşma

Bu tabloyu Burak'a gösterir ve hangi etkinliklerin başlangıç saati dar açılı hangilerininse geniş açılı olduğunu sorar. Burak'a yardım eder misiniz? **(math: 5p)**

Öğrencileri yine gruplara ayırarak bir tanesinin ekran paylaşımı yapıp Geogebra sayfasını açması sağlanır. Diğerleri de tablodaki saatleri söyler ve birlikte linkteki saat üzerinde çizimler yaparak bilmeceyi çözmeleri istenir. Öğrenciler tablodaki *saatleri açılarına göre sınıflandırdıktan sonra sınıf toplanır ve öğretmen kendi ekranında her saati çizerek akrep-yelkovan arasında oluşan açıları belirtir.*

Çadır kurma (30 min)

Aşağıdaki problem öğrencilere sunulur, amaç çadırın kenarındaki şekillerin ikizkenar üçgen olduğunu fark etmeleridir. Eğer problemin ilk kısmında çadırın kenarlarının üçgenlerden tabanın ise kareden oluştuğunu anlamakta zorluk çeken öğrenciler olursa, öncelikle bu zorluğun üstesinden gelmek için https://www.geogebra.org/m/vjrh69jv adresindeki piramit örneği gösterilir, kenarların ve tabanın şekline dikkat çekilir.

Hafta sonu kamp yapmaya giden Aslı ve arkadaşlarının kamp çadırını kurmaları gerekmektedir. Ellerinde aşağıda verilen uzunlukta ve adetlerde çubuklar var.

- 4 tane 1 metrelik
- 4 tane 2 metrelik

4 tane 1 metrelik çubuk kullanarak taban yapıyorlar, geriye 2 metrelik çubukları kalıyor. Bu çubuklarla da aşağıdaki gibi çadırın kenarlarını yapıyorlar. Çadırın tabanındaki ve çevresindeki şekilleri uzunluklarını göstererek çizebilir misiniz? **(math 5p; kare taban & üçgen yanal içi 3 p; doğru uzunluk belirtmeleri için 2p)**

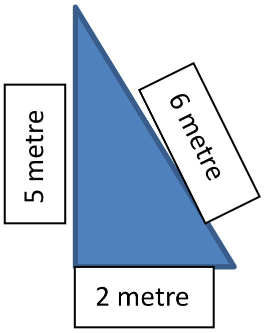
Bu soruyu cevaplamaları için öğrencilere süre tanınır, herkes defterine çizim yapar, öğrenciler çizimlerini bitirdikten sonra öğretmene gösterirler. Öğrencilerin gösteriminden sonra öğretmen ekrana çadırın kenarlarını oluşturan üçgenleri çizer ve iki kenarın eşit olduğu vurgusunu yapar. Ardından aşağıdaki soruyu öğrencilere yönlendirir ve 1.kısımdaki prosedürü tekrar eder.

Yaptıkları çadırın çok yüksek olduğunu fark edince çubukların yerini değiştirip tabanı 2 m çevresini 1 m çubuklarla yaptılar. Yeni çadırın çevresindeki ve tabanındaki şekilleri uzunluklarını belirterek çizebilir misiniz? **(math 5p)**

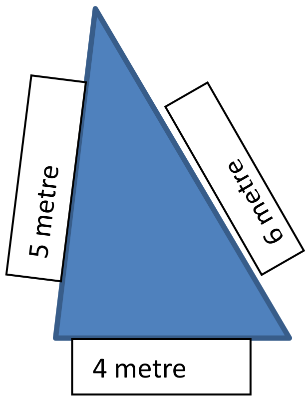
İki kenarın eşitliğine dikkat çektikten sonra bu tür üçgenlere "ikizkenar üçgen" denildiğini söyler. Eğer tabanı oluşturan kare için de kenarları oluşturan çubuklarla eş uzunlukta çubuklar olsaydı ortaya nasıl bir üçgen çıkacağını ekranda gösterdikten sonra bu üçgenlere "eşkenar üçgen" denildiğini söyler ve "Peki ya hiçbir kenarı eşit uzunlukta olmasaydı, o zaman ne isim verebilirdik?" diye sorar ve cevapları toplar, verilen cevaplardan faydalanarak "çeşitkenar üçgeni" tanıtmış olur.

Kaydırak tasarlama (60 min)

Aslı ve arkadaşları gittikleri kamp yerinde büyük bir kaydırak kurulduğunu görürler. Hemen ne kadar büyük bir kaydırak olduğunu incelemeye başlarlar. 5 metrelik yüksekliğe sahip olan bu kaydırak aşağıdaki gibi görünmektedir.



İşçiler, Aslı ve arkadaşlarına ne düşündüklerini sorarlar, Aslı da bu kaydırağın çok dik olduğunu çocukların kayarken düşebileceklerini söyler. Bunun üzerine işçiler başka bir kaydırak için aşağıdaki planı Aslı ve arkadaşlarına gösterir kaydırağın kesinlikle 6 metre olması gerektiğini de belirtirler. Sizce Aslı'lar bu planı güvenli bulmuşlar mıdır?



Aslı ve arkadaşları işçilere nasıl bir kaydırağın daha güvenli olabileceğini göstermek için bir çizim yapmaya karar verirler. Bunu yapmak için https://www.geogebra.org/m/swserdsm#material/k2kw4utt linkindeki uygulamadan faydalanırlar. **(ICT: 10p/ Problemi tanımlama 3p(kaydırak çok dik), link kullanarak farklı üçgenlerde daha az eğimli kaydırak için gerekli örüntüyü bulma 5p, çözümünü değerlendirip kaydırak ve yer arasındaki açı daralmasının gerektiğini gösterme 2p)**

Verilen adresteki uygulamayı öğretmen tanıtır, kaydırağın boyunun 6 metre olması gerektiği hatırlatır ve bunun sabit tutularak diğerlerinin değişimi gösterilir. Sonra, öğrencilerle yukarıdaki adres paylaşılır, her öğrenci bireysel olarak kendi kaydırağını tasarlar. Gerekli süre tanındıktan sonra sınıf toplanır ve kenarlarına ve açılarına göre üçgenlerin 6 türüne de örnek bulunana kadar birkaç öğrenciden kendi tasarladıkları kaydırak taslaklarını göstermeleri istenir. Böylece birbirinden farklı örnekler görmüş olacaklardır.

Eşkenar, ikizkenar ve çeşitkenar; dik açılı, dar açılı ve geniş açılı üçgen isimlendirmeleri öğrencilerin örnekleriyle kategorileştirdikten sonra https://learningapps.org/19524363 adresindeki üçgen eşleştirme aktivitesi yapılır, bu sayede kavramlar pekiştirilmiş olacaktır. Öğrenciler 2-3 kişilik gruplar halinde çalışır, adresi açan bir kişi ekran paylaşımı yapar, dersi anlamayan olduğu taktirde gruptaki diğer kişi açıklama yapar. **(math: 10p/ 3p for using the online tool, 3p for finding 3 types of triangles which were classified in terms of the angles, 4p for naming 6 types of triangles correctly)**

Mathematical Reflections (30 min) Üçgen tablosu

Aşağıdaki sorunun ilk kısmı öğrencilere gösterilir ve defterlerine yazmaları istenir. Bütün öğrenciler defterlerine tabloyu çizdikten sonra yaklaşık 10 dk süre tanınır ve bu sürede her öğrencinin bireysel olarak tabloyu doldurması istenir. Öğrenciler sürenin sonunda 3-4 kişilik gruplara ayrılır ve tablolarında boş kalan yerler varsa bunu tartışmaları istenir. Bu sırada öğretmen gruplara problemin ikinci kısmını gönderir ve grupları ziyaret etmeye devam ederek tartışmayı yönlendirir. Gruplar kendi aralarında tartıştıktan sonra sınıf toplanır öğretmen eşkenar-dik açılı ve eşkenar-geniş açılı üçgenlerin çizilemeyeceğini çünkü eşkenar olması için açıların da eş olması gerektiğini vurgular.

a. Aşağıdaki tabloda boş olan yerlere uygun üçgenler çiziniz. **(7p)**

	Eşkenar	İkizkenar	Çeşitkenar
Dik açılı			
Dar açılı			
Geniş açılı			

b. Tablodaki iki yer doldurulamıyor, hangi ikisine uygun üçgen çizemediniz? Nedenini açıklayınız. **(3p)**

Hafta 3

Kazanımlar:

M.5.2.2.3. Dikdörtgen, paralelkenar, eşkenar dörtgen ve yamuğun temel elemanlarını belirler ve çizer.

Dörtgen Ailesi (60 min)

Problemin ilk kısmı sorulmadan önce Geogebra linki öğretmen tarafından açılır ve ara yüz tanıtılır, değişimleri nasıl yapacakları gösterilir. Problem sorulduktan sonra öğrenciler 3-4 kişilik gruplara ayrılırlar, gruptan bir kişi ekranını paylaşır ve grupça yapılan değişimlere göre dörtgenlerin isimlendirilmesi hakkında çıkarımlar yapılmaya çalışılır.

Birçok dörtgen olduğunu biliyoruz ve bunları kare, dikdörtgen, paralelkenar olarak isimlendiriyoruz. Fakat bu isimlendirmeler nereden geliyor? Hangi özelliklerine göre bu isimler veriliyor? Linki https://www.geogebra.org/m/sWU3h2Jb kullanarak dörtgenlerin ortak ve ayrı özelliklerini belirleyiniz. **(2p)**

1.kısım bittikten sonra öğrenciler tablodaki uygun yerleri 3-4 kişilik (aynı) gruplar halinde https://forms.gle/hhQDQ97FNmNCTU7s9 linkini kullanarak işaretler.

Aşağıdaki tabloda uygun olan yerleri işaretleyiniz. **(5p)**

	1er Karşılıklı kenarları eşit	2şer Karşılıklı kenarları eşit	Bütün kenarları eşit	1er Karşılıklı kenarı paralel	2şer karşılıklı kenarı paralel
Kare					
Dikdörtgen					
Paralelkenar					
EşkenarDörtgen					
Yamuk					

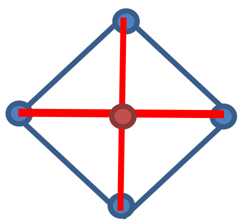
Öğrenciler tabloyu doldurduktan sonra öğretmen Geogebradaki gösterimlerden faydalanarak her bir dörtgen için tablodaki doğru işaretlemeleri yapar. Problemin aşağıdaki son kısmı öğrencilere verilmeden önce Padlet açılır ve soy ağacının nasıl yapılacağı öğretmen tarafından anlatılır. Öğrenciler yine aynı grup arkadaşlarıyla bir araya gelir ve dörtgen soy ağacını düzenler.

Yukarıdaki tabloya göre dörtgen ailesinin soy ağacını aşağıdaki linkte gösteriniz. **(3p)** https://padlet.com/dilekturan44/grjqrtx5zo9seyr8

Oturma Düzeni (30 min)

Pandemi döneminde hayatımızdaki değişikliklerden kısaca bahsedilir, okulda olduğumuz zamanlarda nasıl değişiklikler yaptığımız öğrencilere sorulur. Sınıf içerisindeki oturma düzenine dikkat çektikten sonra aşağıdaki problem öğrencilere sunulur. Soruya bireysel olarak cevap vermeleri beklenir.

Pandemiden dolayı mesafeli oturması gereken 4 öğrenci ve bu öğrencilere grup çalışmalarında yardımcı olan öğretmenin aklına aşağıdaki gibi bir oturma düzeni geliyor, eşkenar dörtgen düzende öğrenciler birbirlerine eşit uzaklıkta oturuyorlar.



Fakat, bu düzende oturunca öğrencilerin ortada oturan öğretmene olan uzaklıkları eşit değil. Öğretmen 4 öğrenciye de eşit mesafede oturmak ve hiçbir öğrencinin başka bir öğrenci yanından geçmeden yanına gelebilmelerini istiyor. Öğrencilerin hem öğretmene hem de birbirlerine eşit uzaklıkta oturabilecekleri oturma düzeni hangi dörtgene benzer?

Öğrencilerden cevapları almak için bir süre beklenir ardından https://www.geogebra.org/m/sWU3h2Jb adresi açılarak kenarların eşit köşegenlerin de eşit olduğu dörtgen, yani kare, bulunur ve sorunun doğru cevabı olarak söylenir.

Öğretmen bir süre sonra öğrencilerin ikili gruplar halinde çalışmalarını ister. Aynı grup içerisindeki 2 kişi birbirine daha yakın diğer ikiliden daha uzak oturacaklardır. Yine dörtlünün arasında oturmak isteyen öğretmen bu kez nasıl bir düzen yapmalı?

Öğrencilerin bu soruda zorlanması durumunda yukarıdaki link paylaşılır. Soru için cevaplar toplandıktan sonra öğretmen ders sonunda öğrencilere kenar uzunluklarının eşit olduğu ve/veya köşegen uzunluklarının eşit olduğu dörtgenleri belirtilen Geogebra adresi üzerinden gösterir.

Code.org Dörtgen Tasarımı (30 min)
(Math 10p; kare oluşturma 5p; dikdörtgen oluşturma 5p. ICT 10p; algoritma yazımı 5p; blok tabanlı programı kullanabilme 5p)

Etkinlik için https://studio.code.org/s/artist/lessons/1/levels/1 sayfasındaki ders kullanılacaktır. Öğrenciler önceki Bilişim Teknolojileri ve Yazılım dersinde code.org web sayfasında çeşitli etkinlikler yaptıkları için sayfayı tanıyorlar. Eğer sayfa ilk defa kullanılacaksa öğretmen öncelikle blok tabanlı kodlama sayfasını tanıtır. Aşağıdaki etkinlik sayfası öğrencilere gönderilir, öğrenciler bireysel olarak çalışır.

Öğrenciler birinci ve ikinci aşamadaki kare ve eşkenar dörtgeni tamamlar, bu sırada öğretmen yardıma ihtiyacı olan öğrencilere destek olur. Bütün öğrenciler bu görevi tamamlayınca öğretmen kendi ekranını paylaşarak bu iki adımı kenar uzunlukları ve açılar açısından değerlendirerek gösterir. Son olarak öğretmen eğer bloklar olmasaydı kare oluşturmak için gerekli algoritmanın aşağıdaki gibi yazılabileceğini öğrencilere gösterir.

- Başlat
- İleriye 100 piksel
- Sağa 90 derece dön
- İleriye 100 piksel
- Sağa 90 derece dön
- İleriye 100 piksel
- Sağa 90 derece dön
- İleri 100 piksel git
- Bitir

Ardından öğrenciler 2 kişilik gruplara ayrılarak bir ***dikdörtgen*** *oluşturmak için blok tabanlı uygulamamız olmasaydı nasıl bir algoritmaya ihtiyaç duyarlardı oluşturmaları istenir***.**

Mathematical Reflection

3 soruluk konu sonu değerlendirme ve öğrendiklerini yansıtma kısmı için öğrencilere https://forms.gle/TdAvpQouncw6oHus8 linki gönderilir. Öğrenciler sorulara cevap verdikten sonra, öğretmen kendi ekranını paylaşarak soruları yanıtlar. Ders kitabındaki konu sonu değerlendirme birlikte çözülür.

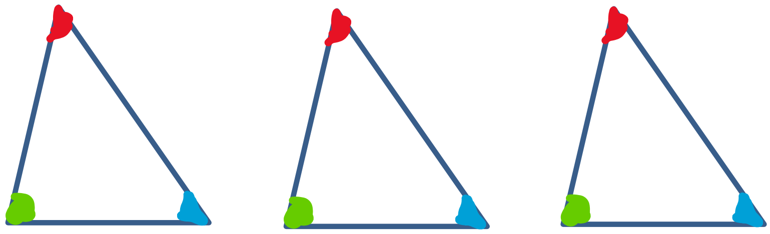
Hafta 4

Kazanımlar:

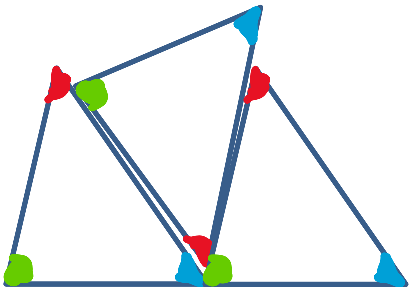
M.5.2.2.4. Üçgen ve dörtgenlerin iç açılarının ölçüleri toplamını belirler ve verilmeyen açıyı bulur.

Üçüz Üçgenler (30 min)

Dersten önce öğrencilerden yanlarında 3 tane kağıt ve 1 makas getirmeleri istenir. Derste öğretmenle beraber bütün öğrenciler ellerindeki üç kağıdı üst üste koyarak üçgen keser, kesilen üçgenin boyutu önemli değil fakat birbirlerine eş olmaları gerekmektedir. Kesilen üçgenlerin açıları aşağıdaki gibi 3 farklı renkle boyanır.



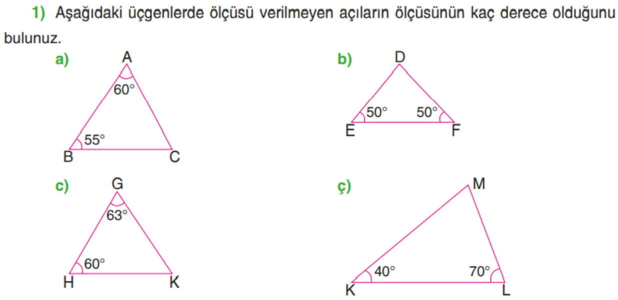
Öğretmen kendi üçgenlerini aşağıdaki gibi, üçgenlerdeki üç farklı açı (üç renk) yan yana gelecek şekilde birleştirir. Bunu yaparken iki üçgenin arasına 3. üçgen ters çevrilerek yerleştirilir. Öğrencilerden de aynı şekilde birleştirmeleri istenir.



Sonrasında öğrenciler 3 kişilik gruplara ayrılır ve aşağıdaki iki soruya cevap vermeleri istenir.

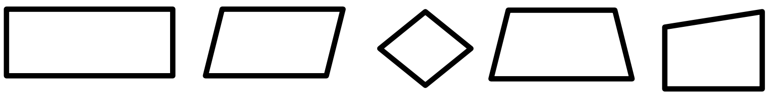
1. Mavi, kırmızı ve yeşil açıların toplamı kaç derecedir? **(math:3p)**
2. Elinizdeki üçgenlerin birinin iç açıları toplamı kaç derecedir? **(math:3p)**

Öğrencilere bu iki soru için 5-6 dk süre sonunda öğrenciler toplanır, cevapları konuşulur, öğrencilerin üçgenin iç açılarının toplamının 180 olduğu kavramaları sağlanır. Bu açıklamalardan sonra öğrenciler gruplara yeniden ayrılır ve ders kitabındaki aşağıdaki soruyu çözerler. ***(math:4p)***



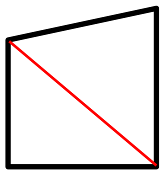
Üçgenden Dörtgene (30 min)

Öğretmen ekran paylaşımı yaparak aşağıdaki gibi çeşitli dörtgenler çizer. Sonrasında öğrencilere aşağıdaki soruyu sorar ve öğrencileri 4 kişilik gruplara ayırarak küçük grup tartışması yapmaları için en az 5 dk süre tanır.



"Üçgenlerin iç açılarının toplamının 180 olduğunu öğrendik. Peki dörtgenlerin iç açıları toplamı kaçtır? Ben cevabı söylemeden de sizler bulabilirsiniz, üçgenler ile ilgili bilgiyi kullanarak sonuca ulaşmaya çalışın."

Yeterli süre verildikten sonra gruplar toplanır. Daha önce çizilen dörtgenler açılarak aşağıdaki gibi birer köşegenleri çizilir. İki üçgen oluştuğu gösterilir ve üçgenlerin iç açıları toplamı 180 dercedir bilgisi hatırlatılarak iki üçgen olduğundan dolayı 180+180=360 derece olduğu açıklaması yapılır. Bu durumda herhangi bir dörtgenin iç açıları toplamı 360 derecedir bilgisi benimsetilmeye çalışılır.



Öğrencilerden 2 farklı dörtgen daha çizerek bunların köşegenlerini göstererek üçgen oluşturmaları ve açılarını göstermeleri istenir.

Ahşap Çerçeve (60 min)

Aşağıdaki çerçeve oluşturma problemi öğrencilere sunulur.

Aslı, Burak ve sınıf arkadaşları dersleri tekrar yüz yüze yapmaya başladıklarında sınıflarına asmak için aşağıdaki gibi bir fotoğraf çerçevesi hazırlamaya karar verirler.

Çevresi 3 metre olabilecek kadar ahşap bulan öğrenciler çerçevenin dörtgen şeklinde olmasına karar verirler. Fakat hangi dörtgen olacağına bir türlü karar vermezler.

Öğrencilere problem sunulduktan sonra aşağıdaki sorular sorulur. B, c, d ve e soruları 2-3 kişilik gruplar oluşturularak yapılır. Öğrencilerden bir tanesi ekranını paylaşır birlikte çözüme ulaşmaları sağlanır. Öğretmen grupları dolaşarak destek olur. Her soru için yeterli süre tanındıktan sonra öğrenciler toplanır öğretmen kendi ekranını paylaşarak birkaç örnek gösterir ve sıradaki soruyu sorar.

Aşağıdaki soruları cevaplayarak Aslı ve arkadaşlarının çerçeveyi oluşturmalarına yardımcı olunuz.

a. Hangi şekilleri kullanabilirler? **(math:2p)**

b. Burak, kare oluşturmanın kolay olacağını düşünüyor, sizce de öyle mi? https://blockly.games/turtle?lang=tr&level=1 linki kullanarak bir kare oluşturur musunuz? **(math:2p, ICT: 3p/1p for loop, 2p for the correct coding)**

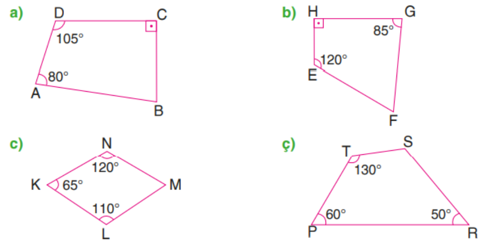
c. Aslı kare oluşturuken bütün kenarları eşit yapmayıp, dikdörtgen oluşturmak istiyor. Siz de https://blockly.games/turtle?lang=tr&level=1 linkini kullanarak bir dükdörtgen oluşturunuz. **(2p, ICT: 3p/1p for loop, 2p for the correct coding)**

d. Aslı ve Burak'ın sınıf arkadaşları paralelkenar yapmaya karar verirler ve aşağıdaki gibi bir başlangıç yaparlar.

Siz de sonraki aşamada kaç derece dönmesi gerektiğine karar verip https://blockly.games/turtle?lang=tr&level=10 linkinde sınıftakilerin çizimlerine devam ederek paralelkenar oluşturmalarına yardımcı olunuz. **(math:2p, ICT:4p/ 2p for loop, 2p for the correct coding)**

Bütün sorular cevaplandıktan sonra öğrenciler toplanır ve dörtgenlerin hep iç açıları toplamının 360 derece olması gerektiği vurgulanır. Bu açıklamadan sonra öğrenciler gruplara yeniden ayrılır ve ders kitabındaki aşağıdaki soruyu çözerler. Öğretmen grupları gezerek destek verir. ***(math:2p)***

2) Aşağıdaki dörtgenlerde ölçüsü verilmeyen açıların ölçüsünün kaç derece olduğunu bulunuz.



Mathematical Reflections (30 min)

https://forms.gle/RZp1dpVadjsPr8p67 adresi öğrencilerle paylaşılır. En az 5 dk süre verilir. Öğrenciler buradaki soruları cevapladıktan sonra öğretmen ders kitabı ünite değerlendirme sorularını öğrencilerle birlikte çözer.

Hafta 5

Kazanımlar:

M.5.2.3.1. Uzunluk ölçme birimlerini tanır; metre-kilometre, metre-desimetre-santimetre-milimetre birimlerini birbirine dönüştürür ve ilgili problemleri çözer.

M.5.2.3.2. Üçgen ve dörtgenlerin çevre uzunluklarını hesaplar, verilen bir çevre uzunluğuna sahip farklı şekiller oluşturur.

Uzunluk ölçüleri dönüşümü (30 dakika)

(Bu dersteki görseller matematik ders kitabından alınmıştır.)

Öğretmen bu derste uzunluk ölçü birimlerinden bahsedileceğini ve birimler arası dönüşümler yapılacağını öğrencilere dersin başında söyler. Öğrencilere bildikleri *uzunluk ölçü birimlerinin neler olduğu sorulur. Aşağıda öğrencilere yöneltilebilecek örnek sorulardan faydalanır:*

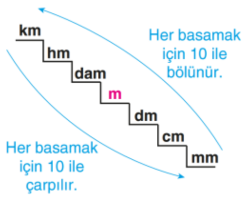
- *Boyunuzu ölçmek için ne kullanıyorsunuz?*
- *Boy uzunluğunuzu tarif ederken hangi birimler kullanılıyor?*
- *Peki ya defterinizin kenar uzunluklarını kullanırken ne kullanırsınız?*
- *Aksaray ile Ankara arası mesafeyi söylerken santimetre kullanmak mantıklı mı sizce?*

Bu sorular öğrencilerin katılımına göre artırılabilir. Ardından farklı uzunluklar için farklı birimler kullandığımız belirtilerek bahsi geçen birimler dışında yeni öğrenilecek, günlük yaşantıda sık kullanmadığımız diğer uzunluk ölçü birimlerinden bahsedilir ve aşağıdaki tablo öğrencilere sunulur ve deftere yazılması beklenir.

Uzunluk Ölçme Birimi	Gösterilişi
Kilometre	km
Hektometre	hm
Dekametre	dam
Metre	m
Desimetre	dm
Santimetre	cm
Milimetre	mm

Transformers çizgi dizisini izleyen öğrencilere orada yaşanan dönüşüm hatırlatılır, arabalar hiçbir eksilme veya ek parça almadan robotlara dönüşüyorlardı. Aynı durum şimdi uzunluk ölçü birimleri arasında da gerçekleşecek. Ölçüler arası dönüşümler yapacağız, değerleri değişmeyecek fakat görüntüleri değişecek.

Öğrencilere 1 metrenin 100 cm olduğu hatırlatılır ve 1 santimetrenin kaç milimetre olduğu sorulur, herkesin cetvellerine bakmaları ve her bir santimetrenin içindeki küçük çizgilerin mm olduğu hatılatılarak kaç mm olduğu sorusu tekrar edilir. *Öğrenciler "1 cm=10 mm" eşitliğine vardıklarında aşağıdaki görsel öğrencilerle paylaşılarak uzunluk ölçü birimleri arasında 10 ile bölme ve çarpmaya dayalı olan ilişkiden bahsedilir.*



Öğretmen aşağıdaki sorulardan birkaçını anlatarak cevapladıktan sonra gerisini öğrencilerin yapmasını bekler, öğrencileri 2-3 kişilik gruplara ayırır ve grup çalışması yapmaları sağlanır. Her öğrenci defterine bu soruları yazar, sonra gruplar toplandığında her gruba *söz hakkı tanınarak soruların doğru yanıtları yapılır.*

<u>Sorular:</u>

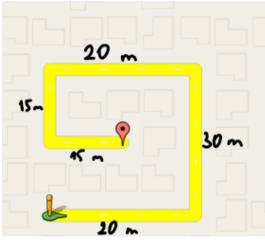
7 km = ... m	0,012 dm = ... mm
14 m = ... cm	310 mm = ... m
700 mm = ... cm	1071 m = ... km
3600 cm = ... m	9 cm = ... m
530 cm = ... mm	4300 dm = ... km
0,75 m = ... cm	120 m = ... km
12,3 km = ... m	8000 dm = ... km

Labirentte mesafeler (30 dakika)

Blockly internet sayfasındaki, BT dersinde kullanıldığı hatırlatılarak, Labirentte kayboldum blockly bulmacasından alınan ekran görüntüleri düzenlenilerek bu etkinlikte kullanılmıştır.

Aşağıdaki problem görsel öğrencilere ekran paylaşımı ile gösterilerek sunulur ve öğretmen tarafından yönlendirilerek öğrencilerin bireyse olarak yapması beklenir.

Bilişim Teknolojileri ve Yazılım dersinden hatırlayacağınız üzere Blockly blok tabanlı kodlama sayfasında “Labirentte Kayboldum” bulmacası bulunmaktaydı. Bu labirentteki adamın aşağıda gösterilen hedefe ulaşması için ne kadar uzunlukta yol yürümesi gerektiğini bulabilir misiniz? **(2p)**



Öğrenciler ardından 2-3 kişilik gruplara ayrılırlar ve aşağıdaki soruları sırasıyla çözmeleri istenir. Sorular çözüldükten sonra gruplar öğretmene çözümlerini gönderir, sınıf toplanır ve öğretmen çözümleri öğrencilerle birlikte bulur.

- Evet sizin de bulduğunuz gibi bütün yol toplamda 100 metre yol yapıyor. Bu mesafenin aşağıdaki dönüşümleri yaparak farklı birimlerde gösterimlerini belirleyebilir misiniz? **(5p)**
    - 100 metre = ……… dm
    - 100 metre = ……… cm
    - 100 metre = ………mm
    - 100 metre = ………dam
    - 100 metre = ……… hm
- Labirentteki adamın sağlıklı yaşam için günlük 1 km hedefi bulunmaktadır. Bu labirentteki mesafeyi yürüdükten sonra kaç metre daha yürürse hedefine ulaşmış olur? **(3p)**
- İkili gruplar halinde toplanalım ve gruptan bir kişi kendi labirentindeki damın sonuca gidene kadar algoritmasını yazsın, diğer kişi de bu uzunluğum birimler arası dönüşümünü yapsın. **(ICT: 10p)**

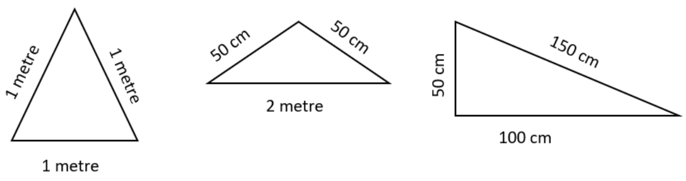
Ahşap Çerçevenin Şekli (30 dakika)

Bir önceki haftanın ahşap çerçeve problemine gönderme yapılarak aşağıdaki problem sunulur.

Hatırladığınız gibi geçen hafta öğrenciler 3 metrelik ahşap ile sınıflarına bir çerçeve oluşturmak istiyorlardı. Hangi şekilleri yapmaya çalıştıklarını hatırlıyorsunuzdur. Neleri denemişlerdi sayabilir misiniz?

Öğrencilerden paralelkenar, kare, dikdörtgen cevapları vermeleri beklenir. Ardından aşağıdaki açıklama yapılır. Öğrencilerin üçgenlerini bireysel olarak defterlerine çizmeleri beklenir.

Evet bu dörtgenleri yapmaya çalışmışlardı, peki üçgen yapmaya çalışsalardı farklı farklı üçgenler oluşturabilirlerdi değil mi? Aşağıdaki örneklerde 3 metrelik çevreye sahip üçgenler çizdim ben.



Gördüğünüz gibi aynı çevre uzunluğuna sahip birbirinden farklı üçgenler çizebiliyoruz. Siz de benim gibi 3 metre çevre uzunluğuna sahip bir üçgen çizer misiniz? **(4p)**

Öğrenciler defterlerine üçgen çizdikten sonra öğretmen sınıftan birkaç öğrenciden çizdikleri üçgeni göstermesini/söylemesini/ekranda çizmesini ister. Ardından aşağıdaki soruyu sorar, öğrenciler soruyu çözmek için 2-3 kişilik gruplar oluştururlar.

Üçgen pano yapmak pek hoş görünmeyeceğini düşünen öğrenciler yine dörtgen yapmaya karar verirler. Fakat bu kez eşkenar dörtgen ve yamuk gibi önceki seferde denemedikleri dörtgenleri de denerler. Siz de çevre uzunluğu 3 metre olacak şekilde bütün bu dörtgenler çizer misiniz? Önceki çizdiklerinizden farklı kenar uzunlukları kullanmaya çalışın. **(6p; 4p for correct perimeter and 2p for using different units)**

Öğrenciler grup içerisinde ekran paylaşımı yaparak çizdikleri dörtgenleri ve belirledikleri kenar uzunluklarını ekran görüntüsü alarak öğretmenlerine gönderirler. Dersin son 5 dakikasında sınıf toplanır ve birkaç örneğe birlikte bakılır. Öğretmen aynı çevre uzunluğuna sahip farklı şekiller çizilebileceği vurgusu yapar ve dersi sonlandırır.

Okul bahçesinde yarışma (30 dakika)

Aşağıdaki soru sırasıyla öğrencilere sunulur. Öğrenciler sorunun ilk iki kısmını (a ve b maddeleri) öğretmenle beraber sınıfça çözdükten sonra 2 kişilik gruplara ayrılır ve soruların geri kalanını yapmaları beklenir. Bütün sorular cevaplandıktan sonra (yaklaşık 15 dk süre verilir) sınıf tekrar toplanır ve birlikte cevaplar kontrol edilir.

Bizim Aslı okullar açılınca sınıf arkadaşlarıyla bir yarışma içerisine girmiş, arkadaşlarına 20 dakika içerisinde kim daha fazla mesafeyi koşabilecek diye yarışa girmişler ve kare şeklindeki okul bahçesinde koşmaya başlamışlar. Yarış sonunda Aslı ve arkadaşları aşağıdaki tabloda belirtilen miktarda koştuklarını görmüşler.

(10p; 2p for each question)

Aslı	2 tur
Burak	1,5 tur
Mehmet	2 tur
Doruk	2,5 tur
Ada	3 tur
Nur	1 tur

a) Kim birinci olmuştur?

b) Okul bahçesinin çevresi 200 metre olduğuna göre birinci olan kişi kaç metre koşmuştur?

c) Sonuncu olan kişi kaç metre koşmuştur?

d) Bahçenin bir kenarı kaç metre uzunluğundadır?

e) Yarış yapıldıktan sonra pandemiden dolayı başka şehre giden sınıf arkadaşlarından birisi olan Metin'e telefonda yarışı anlatmışlar ve Metin de "Keşke ben de okulda olsaydım da sizinle yarışsaydım." demiş. Bunun üzerine metin'e 20 dk içerisinde kaç metre koştuğunu kendisi kaydederse bizim sıralamamıza katılabilir önerisinde bulunur sınıftakiler. Metin 20 dakikada 550 metre koştığuna göre sınıfta kaçıncı sırada olur?

Mathematical Reflection (30 dakika)

https://forms.gle/8eto8u32GPf3cByC7 *linki öğrencilere gönderilir, yaklaşık 10 dk süre tanınır.*

Matematik ders kitabı sayfa 240-241'deki 6 sorudan oluşan konu sonu alıştırmanın ilk iki sorusu öğretmen tarafından ekran paylaşımı yapılarak anlatılarak çözülür, diğer dördünü öğrencilerin 2 kişilik gruplar halinde çözmeleri ve öğretmene göndermeleri beklenir.

APPENDIX P

LESSON PLANS

ICT

Week 1

Objectives:

5.5.1.15. Draws a flowchart for an algorithm.

Word processing programs or other drawing programs are used for the electronic drawing of the flow chart.

5.5.1.16. Debugs by testing an algorithm.

Robot's route

In the course, students are expected to develop the flow chart they created for the robot they used in the previous week to go to the specified target. The following problem is presented to the students.

Problem 1.1: The new platform on which the robot will move is given in the image below, the blue area represents the location of the robot.

							D		
		A				**E**			
				B					
		C							
							F		

Our robot wants to go to point A, but on the way there, it should not enter the boxes with other points. Can you make a flowchart for the robot to follow?

Students are asked the following questions:

• “What is the position of point A relative to the Robot?”

• “What is the location of point B relative to the Robot?”

• “What is the position of point A relative to point B?”

• “Does the robot have to go through point B while taking the shortest route to point A?”

After answering these questions as a whole class, students are asked to solve the problem by dividing them into groups of 3-4. Groups are given the following link so they can create their flowcharts:

https://docs.google.com/drawings/d/1ivmKxk-AT5y-4t_AJcuUG-skPzqE5qC0-j4x9bVlSyQ/edit?usp=sharing

Separate pages are created for each group, one of the group members shares his screen and arranges the flowchart elements on the page with his friends.

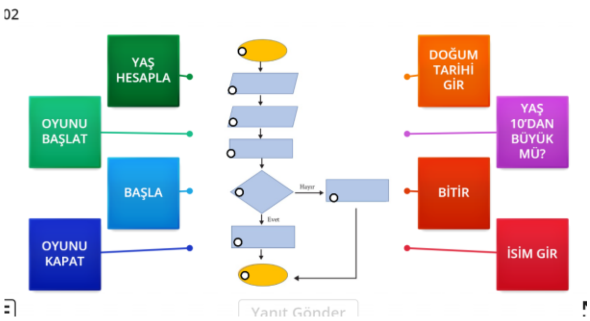
At the end of the activity, the groups come together, and the teacher draws the robot's route according to the algorithm created by each group on his screen and delivers the robot to the target.

Flowcharts Are Entangled

The following scenarios are read to the students and they are asked to draw a flow chart suitable for these scenarios. To draw the flowchart

https://wordwall.net/en/resource/14287048/ak%c4%b1%c5%9f-%c5%9femalar%c4%b1-kar%c4%b1%c5%9fm%c4%b1 It is expected to match the %c5%9f-scenario-3 link. There is an example from this link in the image below.

Students are divided into groups of 3. A scenario is assigned to each group, making sure that all 3 scenarios are given. One person from the group enters the link by sharing the screen, the other two people open the scenario and read it step by step, and the steps of the flow chart are decided as a group.



Scenarios:

Scenario 1: Alperen is an 8th grade student. Alperen's mother only allows him to sleep at 23.00 on Saturday evenings, and asks him to sleep at 21.00 on other days. Alperen has added a reminder to his mobile phone to remind him of bedtime. Create the flowchart of the operation of this reminder.

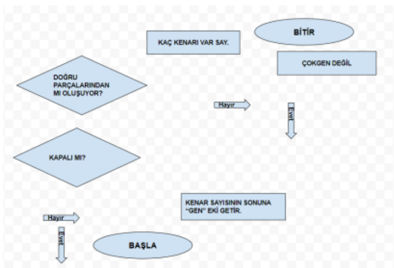
Scenario 2: Nilüfer in the elevator she took with her father 'Max. He read the text '250 kg' and asked his father what it meant. His father stated that the lift can carry a maximum load of 250 kg, and that it does not work when the lift weighs more than 250 kg. Create a flowchart describing how the elevator works.

Scenario 3: Ahmet Bey bought a computer game for his son Mert to play. It is written on the computer game that it is 10 years and older. Since Mert is 11 years old, he starts playing the game by installing it on his computer. Mert's 8-year-old brother Efe is also curious about the game and wants to open the game when his brother is not at home. However, before the game starts, Efe has to write his name and date of birth on the screen. Efe enters this information, but the game does not start. What kind of flowchart do you think the computer used for this situation?

What is the name of the polygon?

Students are told that there is a decision-making process when naming polygons and they should organize this process themselves.(ICT (10p): algorithm 3p, correct flowchart 5p, using online drawing prog 2p. Math(10p): mathematical info in the flowchart 5p, table 5p)

https://docs.google.com/drawings/d/1eiWMQ7o1txv2E5SXdtX7bu3V7O_9GoUgdubJBE2DLvo/edit



After the flow chart in the link is arranged, the students are given the time to speak and to fill the table below.

Shape	Number of Edge	Name of the Polygon

What did we learn?

At the end of the lesson, students are asked where flow charts can be used. The relationship with mathematics is emphasized. Examples of the use of flow charts in other scientific processes are given.

Week 2

Objectives:

5.5.1.1. It offers solutions to the problems encountered in daily life.

5.5.1.2. Solves a given problem using appropriate steps.

It is emphasized that different algorithms can be designed to solve a problem.

5.5.1.4. Recognizes the steps to be followed in the problem solving process.

5.5.1.5. Analyzes a given problem.

5.5.1.6. Explains the variables, constants and operations required to solve the problem.

Tangram

To use the Tangram activity, the link https://tr.mathigon.org/tangram will be used. Before dividing them into groups at the entrance to the activity, the teacher shares the screen and shows how to move the tangram pieces. Then, a classical tangram shape is created as in the image below and students are tried to become familiar with the application.

After the application is introduced, the students divide into groups of four and explain the tasks of the group.

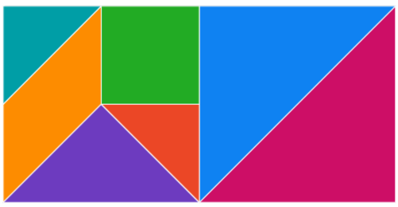
<u>Duties of group members:</u>

• 1 person enters the application with the link and shares the screen.

• 2 people describe the way the teacher will show to their group friend, explain which piece to put where and how much to rotate it. (There can be 1 person if there are not enough students.)

• 1 person writes the flow chart of this description process.

After the students are divided into groups, the members to whom the figure will be shown are presented with the following image and given 1 minute, and then they are sent to their friends to examine the figure.



Friends will be given 10 minutes to describe this figure and to prepare the flowchart of the group.

The teacher supports the groups during this time. When all groups have filled their time, the class gathers and each group shows their flowchart to the teacher, the teacher controls each flowchart by applying it himself.

At the end of the activity, it is emphasized that different flow charts can be created for a simple geometric shape. In more complex forms, it is mentioned that these flow charts will also develop and become more complex.

Variables

The poem entry from the "Variables in the Envelope" activity given in the guidebook is used.

The following poem is read with the names of a few people from the class:

Matt opened his eyes.

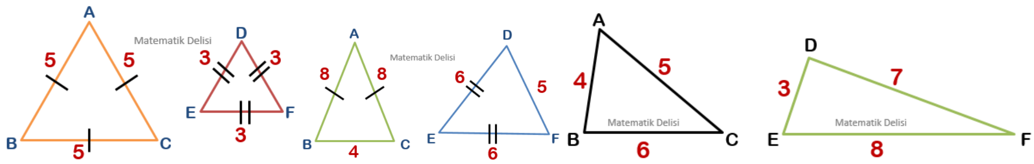
The sun has escaped your heart

….

Furkan opened his eyes.

The sun has escaped your heart

Note that it would take too long to do this for the whole class. The following sample triangles are then shown.



Side lengths are written to denote each triangle (5-5-5 triangle; 3-3-3 triangle, etc.). Students are given the following explanation:

"Trying to describe all the triangles that come up in this way is as difficult as trying to write the same poem with the names of everyone in the class. So maybe an easier way can be found by paying attention to what has changed in the examples given."

The teacher circles the names in the poems and writes "name". He says that if any other name is written on the place where the name is written, there will be no problem in the poem. Makes a few tries.

"Would our poem still be correct if we wrote 'age' instead of name?" After he asks, the age of a few students is asked and written instead in the poem. It is shown that it is not a correct placeholder.

The https://learningapps.org/display?v=pxtrm2hqt20 link opens and the screen is shared, the students match the variables with the correct placeholders together with the teacher.

Triangle images are opened again, and it is discussed whether a "placeholder" can be given for these triangles as well. Students are expected to come up with the idea that these triangles can be classified according to their sides. They are guided by asking questions to reach the names of "scalene, equilateral, isosceles" by asking what the differences and similarities of the sides of the triangle are from each other.

Week 3

Objectives:

5.5.1.2. Solves a given problem using appropriate steps.

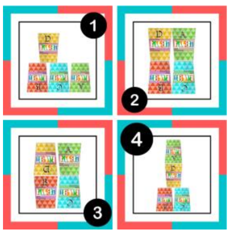
5.5.1.5. Analyzes a given problem.

5.5.2.2. Recognizes the interface and features of the block-based programming tool.

The Cups

The activity titled "I'm Writing a Story - I'm Starting Programming" in the Information Technologies and Software guide will be held with students. Some changes have been made for distance education. The address: https://bilgebt.com/2021/04/23/d2-11-hafta-5-sinif-hikaye-yazyim/

Students are divided into groups of 4-5, one opens the given link and shares the screen, one writes down the steps to be done in his notebook, while the others tell the steps to be taken. Below are screenshots on the bilgeBT activity. The first activity is done by the teacher, it is written step by step and the students are shown what the expectation from the activity is.



After the students have prepared all the glass arrangements, the class gathers, the teacher listens to the sequence steps from each group as long as time allows and gives examples of the correct demonstrations by sharing his own screen. (6p for correct positioning of glasses, 4p for writing algorithms)

Create a polygon

Students form groups of 2. They are expected to perform the activity, a screenshot of which is given below, at the address https://ders.eba.gov.tr/ders//redirectContent.jsp?resourceId=f06538f5249552c452d239bb1b77f3a5&resourceType=1&resourceLocation=2 on EBA.

In this activity, one of the students in the group shares the screen and the other tells them to draw a line segment passing through which point in each step so that they can make the desired rectangle in the activity. The fact that there is more than one alternative in a rectangle, parallelogram and trapezoid will guide the students that the right solution is not the only one.

Below is a sequence that will be shown to the students as an example before the activity.

• Line segment passing through the upper point and the point to the right of 4 br

• Line segment passing through the lower point and the point to the right of 4 br

• A line segment connecting the points created in the first two steps is drawn.

After the above example is shown to the students, the groups are divided and they try to make the desired quadrilaterals. The teacher supports the groups by visiting them throughout the lesson.

Week 4

Objectives:

5.5.2.1. Explains the basic concepts of programming.

5.5.2.2. Recognizes the interface and features of the block-based programming tool.

5.5.2.3. It creates the right algorithm to achieve the goals presented in the block-based programming environment.

5.5.2.7. Develops algorithms including decision structures.

Blockly intro (10 min)

The Blockly presentation in the Information Technologies and Software course guidebook is made.

Blockly Puzzle (20 min)

The Puzzle page, which is the first activity on the Blockly page, opens, and the following block introductions, which are also mentioned in the BTY guidebook, are made. Students are familiar with block-based programs as they have worked on Code.org before. It is mentioned that the blocks will be moved in line with the instructions shown on this page, and a cat example is made and shown to the students.

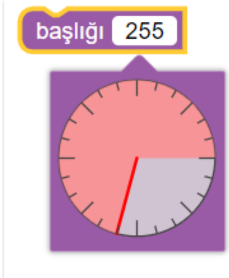
Then, students go to https://blockly.games/puzzle?lang=tr and solve the puzzles of other animals individually.

In the last 5 minutes of the lesson, the whole class gathers, the teacher shows the correct solutions on his screen, takes any questions and ends the lesson.

Bird is looking for food (30 min)

Since various quadrilaterals will be created using the turtle activity in the mathematics lesson, the first 3 stages of the "Bird" activity will be done in order to better understand the angles over blockly.

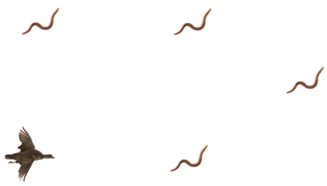
As seen in the image below, the teacher asks the students how many degrees of rotation should be made for a tour in order to remember the angles on this clock. Thus it is mentioned in full view; Then, by asking the concepts of right angle, right angle, acute angle and wide angle one by one, and then on the clock.



Then the link https://blockly.games/bird?lang=tr is shared with the students and they are given a maximum of 5 minutes to complete the first stage. After 5 minutes, the class gathers and the teacher opens the correct answer by sharing his/her own screen. **(ICT: 4p)**

Then the teacher shows the students the following image and asks the following question:

The bird below is very hungry and wants to eat the 4 worms around it in as few steps as possible. What route should it follow for this? Can you write the step-by-step route with the rotation angles? **(math:10p/ 2.5p for each correct angle, ICT:4p/ 2p for writing each step correctly and 2p for requiring the minimum step condition)**



Students divide into groups of 2-3 and try to create the route. Meanwhile, the teacher circulates the groups and helps when support is needed. After a maximum of 10 minutes, the class convenes. The routes found by the groups are listened to one by one. Different routes will be drawn, these routes are also shown on the visual by the teacher and written step by step.

Then, https://blockly.games/bird?lang=tr, the teacher introduces the second stage by screen sharing, the "if" structure is explained and how it works is shown. The link is sent to the students again, and they are asked to complete the second and third stages individually. In the last few minutes of the lesson, the class gathers and the teacher shows the answer of the third step and ends the lesson. **(ICT:2p for the if condition)**

Mathematics Lesson Plans

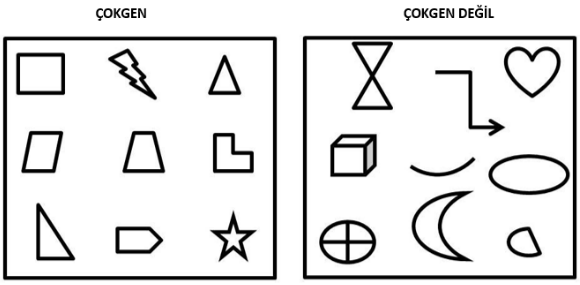
Week 1

Objectives: Names and creates polygons and recognizes their basic elements.

Which one is polygon? (20 min)

Students are presented with the following table of shapes with and without polygons. It is discussed on the basis of which criteria the distinction is made here.

Note: In the ICT course, a lecture on the conditions of being a polygon must have been done.



Then, the link https://learningapps.org/19446323 is opened (there is a screenshot from the link below).

Students are divided into groups of 3-4 people, one person is provided to share the screen and they are expected to do this drag and drop activity as a group.

Tangram Algorithm (30 min)

Tangram pieces are introduced, it is shown that these pieces combine to form a square. It is mentioned that different geometric shapes can be created using some parts. For example, quadrilaterals are created by positioning two triangles differently.

The following figures are then shown and show how they were created at https://en.mathigon.org/tangram. At this stage, the names of the polygons are not said.

Then, by sharing the link https://tr.mathigon.org/tangram, the students are asked to combine the tangram pieces as shown in the example and make at least 2 different shapes. Groups of 2-3 people are formed, one person from the group shares their screen and works with their friends. Ask each group to take screenshots of the shapes they made.

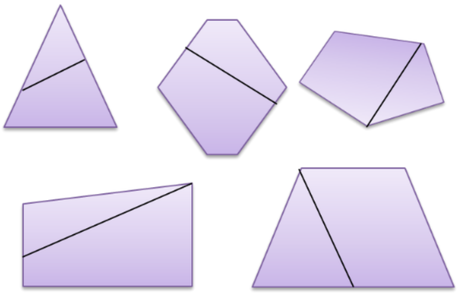
After the groups make their shapes, the class gathers, each group is asked what shapes they made, and the students show their shapes. After looking at the shapes of several groups, the teacher poses the following question:

“Don't you think it'll take us a long time to look at them one by one? It might be easier if we say the names of these shapes instead of showing them, what do you think?"

Thus, it is decided to give names to the shapes made and it is mentioned that they can be named according to the number of sides. The teacher opens the images in Picture3 and names the polygons by adding "-gen" to the end of the number of sides. It enables students to apply the same naming strategy. **(math (10p) creating a polygon 5p; naming the formed polygon by adding gene suffix to the end of the number of vertices 5p)**

The Mystery of Diagonals - Part 1 (20 min)

The following polygon images are shown to students. If these polygons are cut from the black line segments, the students are asked how many sides the new polygons can have.



After determining the number of sides, as shown in the example, together with the students, they are asked whether the number of sides in the newly formed shape relationship has with where we cut from the shape, and the students are asked to discuss this as a group by dividing them into groups of 4.

When the groups are reconvened, the comments are listened to, and answers are expected from the students that cutting the corners causes less number of edges than the others. If they could not reach this conclusion, additional questions can be asked to reach them by showing a few more examples. (“Do you think there are twice as many sides each time we cut the shape in half?” “Some of them originally had 4 sides, but when you cut it, it had less than twice as many sides, why do you think?”)

When it is noticed that when it is cut from corner to corner, it is noticed that there are always fewer edges than the cutting parts, and "This cutting line segment has a special name, what do you think it might be called?" they are expected to reach the diagonal name by saying. As an aid, it is reminded that the suffix "-gen" is popular in polygons.

The mystery of diagonals (60 min)

The course is taught in line with the following problems.

After the question 1 is presented to the students, an example is made on the page used to draw a polygon using the link provided. Students individually draw their shapes. A few students are expected to show the hexagons they have drawn by sharing the screen.

For the first two lines of the table in Question 2, the teacher draws the polygons on the web page and indicates the diagonals, and the table is filled by the class. Students are divided into groups of 4-5 to fill in the other rows. After completing the rows in the table, the class gathers and the teacher shares a full table. If students need time to discuss the relationship between the numbers of sides and diagonals, they divide into groups again.

After specifying the relationship between the numbers of diagonals and sides, students are given time for Question 3. At the end of the lesson, it is discussed what a diagonal means and how to find the number of diagonals in a polygon.

<u>Questions:</u>

1. 5th grade student Aslı drew a hexagon (a polygon with 6 sides) in her notebook and determined all the diagonals in this polygon. How many diagonals did Aslı draw? Show by drawing a figure.

You can draw using https://www.geogebra.org/m/j8etmmwh here. **(3p)**

2. Her teacher tells Aslı that no matter which polygon she draws, she can know the amount of diagonals. In order to understand how she did this, Aslı drew heptagons and octagons and determined the diagonals of these shapes. He drew a table to see if there is a relationship between the number of sides and the diagonals of the figures. Help him search for the relationship by filling in the table below.

Number of Edges	Number of Diagonals
6	
7	
8	

Did you find a relationship between the numbers of sides and diagonals? Please explain. (4p)

3. Aslı's classmate Burak says that she drew a shape and that the number of diagonals of this shape is 5, but Aslı claims that this is impossible. Do you think Asli could be right? Why? **(3p)**

Mathematical Reflections (10 min)

There are 2 questions at https://forms.gle/wN1LKwKRyk5zEYeA9 to reflect on what they learned this week. In the last lesson of the week, they are expected to fill out this form. When all students send their answers, the questions are answered briefly and the lesson ends.

Week 2

Objectives:

M.5.2.2.2. Creates triangles according to their angles and sides, classifies the different triangles created according to their side and angle properties.

Angles in Hour (30 min)

During this event, https://cutt.ly/ovCd4IW and https://www.geogebra.org/m/dfwwz8cu addresses will be used. Students are presented with the following problem. Then, the first internet address is shared, and the students are divided into groups of 3-4 and they are expected to answer the question.

Aslı asks her friend Burak a riddle: The hour and minute hands make a 90 degree angle and the minute hand is over the number 3. But if the hour hand is not above 12, what time is it?

Since Burak got the correct answer, what time did he say it was? **(math: 5p)**

The answers from the students are checked and the concept of 90 degrees, that is, right angles, is reminded. In order to repeat the wide and narrow angles, the following question is shared with the students.

Seeing that Burak quickly gets the right answer, Asli prepares the table below, which contains part of a weekend plan, to complicate things a little more.

Time	Activity
9.30	Breakfast
11.00	Homework
12.15	Cartoon
13.15	Reading Book
14.35	Meet with friends

He shows this table to Burak and asks which activities have narrow angle and which wide angle. Can you help Burak? **(math: 5p)**

By dividing the students into groups, one of them is allowed to share the screen and open the Geogebra page. Others tell the clocks on the table and together they are asked to solve the riddle by drawing on the clock in the link. After the students classify the clocks in the table according to their angles, the class gathers and the teacher draws each clock on his screen and indicates the angles formed between the hour and minute hands.

Pitching the tent (30 min)

The following problem is presented to the students, the aim is for them to realize that the shapes on the edge of the tent are isosceles triangles. If there are students who have difficulty in understanding that the sides of the tent are triangles and the base is square in the first part of the problem, first of all, the pyramid example at https://www.geogebra.org/m/vjrh69jv is shown and attention is drawn to the shape of the sides and base.

Aslı and her friends, who are going camping at the weekend, have to set up the camping tent. They have sticks of the length and quantity given below.

• 4 pieces of 1 meter

• 4 pieces of 2 meters

They make a base using 4 1 meter sticks, leaving 2 meter sticks. With these sticks, they make the sides of the tent as follows. Can you draw the shapes at the base and around the tent showing their lengths? **(math 5p; square base & triangle lateral inside 3p; 2p for correct length indications)**

Students are given time to answer this question, everyone draws in their notebooks, and after the students finish their drawings, they show it to the teacher. After the students' demonstration, the teacher draws the triangles forming the sides of the tent on the screen and emphasizes that the two sides are equal. He then poses the following question to the students and repeats the procedure in Part 1.

When they realized that the tent they had built was too high, they decided to move the sticks. They made the base with 2-meter sticks and the perimeter with 1-meter sticks. Can you draw the shapes around the base and around the new tent, specifying their lengths? **(math 5p)**

Again, after drawing attention to the equality of the two sides, he says that such triangles are called isosceles triangles. After showing by drawing on the screen what kind of triangle would appear if the square forming the base had bars of equal length with the bars forming the sides, he said that such triangles are also called "equilateral triangles". Then he said, "What if all of its sides were of equal length, then what would we call it?" He asks and collects the answers, and by making use of the answers given, he introduces the scalene triangle.

Designing a slide (60 min)

Aslı and her friends see that a big slide has been set up at the campsite they went to on the weekend. They immediately go and begin to examine how big a slide it is. The slide looks like the following at first. The dimensions of this slide, which has a height of 5 meters, are also shown.

Asli and her friends decide to make a drawing to show the workers how a slide can be safer. To do this, they use the application at the link https://www.geogebra.org/m/swserdsm#material/k2kw4utt. **(ICT: 10p/ Defining the problem 3p(slide too steep), finding the necessary pattern for the slide with less**

slope in different triangles using the link 5p, evaluating the solution and showing that the angle between the slide and the ground needs to be narrowed 2p)

The teacher introduces the application at the given address, reminds that the length of the slide should be 6 meters, and the change of the others is shown by keeping it constant. Then, the address above is shared with the students, and each student individually designs their own slide. After the required time is given, the class gathers and several students are asked to show their slides sketches that they have designed until all 6 types of triangles are found according to their sides and angles. Thus, they will see different examples from each other.

equilateral, isosceles and scalene; After categorizing the right-angled, acute-angled and obtuse-angle triangle nomenclature with the examples of the students, the triangle matching activity at https://learningapps.org/19524363 is done, so the concepts will be reinforced. Students work in groups of 2-3 people, a person who opens the address shares a screen, if the other person in the group does not understand the lesson, the other person in the group makes a statement. **(math: 10p/ 3p for using the online tool, 3p for finding 3 types of triangles which were classified in terms of the angles, 4p for naming 6 types of triangles correctly)**

Mathematical Reflections (30 min) Triangle chart

The first part of the question below is shown to the students and asked to write in their notebooks. After all students draw the table in their notebooks, approximately 10 minutes are given and each student is asked to fill in the table individually during this time. At the end of the period, students are divided into groups of 3-4 and asked to discuss if there are any empty spaces in their tables. Meanwhile, the teacher sends the second part of the problem to the groups and continues to visit the groups, leading the discussion. After the groups have discussed among themselves, the class gathers. The teacher emphasizes that equilateral-right-angled and equilateral-obtuse triangles cannot be drawn because the angles must be congruent in order for them to be equilateral.

a. Draw appropriate triangles in the empty spaces in the table below. **(7p)**

	Equilateral triangle	**isosceles triangle**	**scalene triangle**
right triangle			
Acute triangle			
obtuse triangle			

b. Two places in the table cannot be filled, which two could you not draw a suitable triangle? Explain why.

The Quadrilateral Family

We know that there are many quadrilaterals, and we call them square, rectangle, parallelogram. But where do these nomenclatures come from? According to what characteristics are these names given? Use the link https://www.geogebra.org/m/sWU3h2Jb to determine the common and distinct properties of the quadrilaterals. **(2 points)**

Please mark the appropriate places in the table below by using the following link https://forms.gle/hhQDQ97FNmNCTU7s9. **(5 points)**

	One pair of sides is equal	Two pairs of sides are equal	All sides are equal	One pair of sides is parallel	Two pairs of sides are parallel
Square					
Rectangle					
Parallelogram					
Rhombus					
Trapezoid					

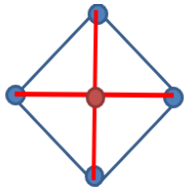
Show the quadrilateral family tree in the link below according to the table above. **(3 points)**

https://padlet.com/dilekturan44/grjqrtx5zo9seyr8

Sitting Arrangement (30 min)

Changes in our lives are briefly mentioned during the pandemic period, and students are asked how we make changes when we are at school. After drawing attention to the seating arrangement in the classroom, the following problem is presented to the students. They are expected to answer the question individually.

4 students who need to sit at a certain distance due to the pandemic and the math teacher who helps them in group work with these students need a seating arrangement. For this, the following scheme came to mind. The teacher thinks of a seating arrangement like the one below, in this rhombus-shaped arrangement, the students sit at an equal distance from each other.



However, when sitting in this order, the distances of the students to the teacher sitting in the middle are not equal. The teacher wants to sit at an equal distance from all 4 students and that no student can come directly to him without passing by another student. Which quadrangle is similar to the seating arrangement in which students can sit at equal distances from both the teacher and each other?

After waiting for a while to get the answers from the students, the address https://www.geogebra.org/m/sWU3h2Jb is opened and the rectangle, that is, the square, where the sides are equal and the diagonals are equal, is found and said as the correct answer to the question.

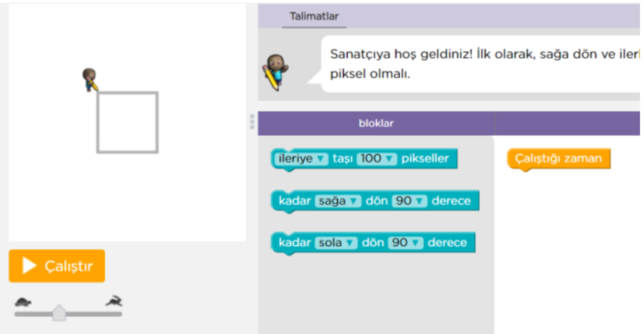
After a while, the teacher asks the students to work in pairs. 2 people in the same group will sit closer together than the other couple. How should the teacher, who wants to sit between the four again, arrange this time?

If students have difficulty with this question, the link above is shared and they are expected to reach the result by changing the side lengths here. After the answers for the question are collected, the teacher shows the students at the end of the lesson the quadrilaterals with equal side lengths and/or equal diagonal lengths via the given Geogebra address.

Code.org Quadrilateral Design (30 min)

Scoring: Math (out of 10p) = creating square 5p; creating rectangle 5p. ICT (out of 10p) = writing the algorithm correctly 5p; using the block-based program 5p)

The course at https://studio.code.org/s/artist/lessons/1/levels/1 will be used for the activity. Students get to know the page because they did various activities on the code.org web page in the previous ICT course. If the page is to be used for the first time, the teacher first introduces the block-based coding page. The following activity sheet is sent to students, students work individually



Students complete the square and rhombus in the first and second stages, while the teacher supports the students who need help. When all students complete this task, the teacher shares her screen and demonstrates these two steps in terms of side lengths and angles. Finally, the teacher shows the students that if the blocks did not exist, the algorithm for creating a square could be written as follows.

- start
- Forward 100 pixels
- Turn right 90 degrees
- Forward 100 pixels
- Turn right 90 degrees
- Forward 100 pixels
- Turn right 90 degrees
- Go forward 100 pixels
- Finish it

Then, the students are divided into groups of 2 and asked to create a rectangle what kind of algorithm they would need if we did not have a block-based application.

Mathematical Reflection

For the 3-question end-of-topic evaluation and reflection part, the students are sent the link https://forms.gle/TdAvpQouncw6oHus8. After the students answer the questions, the teacher answers the questions by sharing their screen. The end-of-topic evaluation in the textbook is solved together.

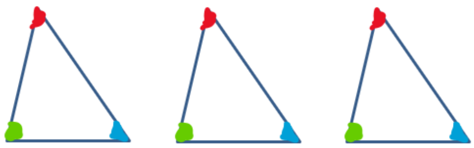
Week 4

Objectives:

M.5.2.2.4. Determines the sum of the measures of the interior angles of triangles and quadrilaterals and finds the missing angle.

Triple Triangles (30 min)

Before the lesson, students are asked to bring 3 pieces of paper and 1 scissors with them. In the lesson, together with the teacher, all students put three pieces of paper on top of each other and cut triangles. The size of the cut triangle is not important, but they must be equal to each other. The angles of the cut triangles are painted with 3 different colors as follows.



The teacher connects his triangles as follows, with three different angles (three colors) in the triangles side by side. While doing this, the third triangle is placed between the two triangles by inverting them. Students are asked to combine in the same way.

Afterwards, students are divided into groups of 3 and asked to answer the following two questions.

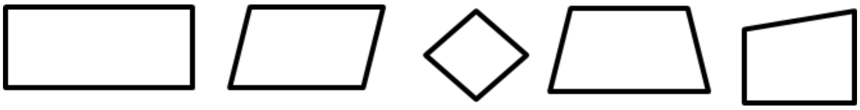
1. What is the sum of the blue, red and green angles in degrees? **(math:3p)**

2. What is the sum of the interior angles of one of the triangles in your hand, in degrees? **(math:3p)**

Students are given 5-6 minutes to answer these two questions. At the end of the time, the students are gathered, and their answers are discussed. And students are made to realize that the sum of the interior angles of the triangle is 180. After these explanations, students divide into groups again and solve the question in the textbook. The teacher supports the groups by visiting them. **(math:4p)**

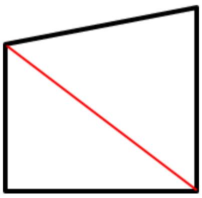
Triangle to Quadrilateral (30 min)

Students draw a rectangle in their notebooks. The teacher also draws various rectangles as follows by sharing the screen. He then asks the students the following question and divides the students into groups of 4, giving them at least 5 minutes to have a small group discussion.



“We learned that the sum of the interior angles of triangles is 180. What is the sum of the interior angles of the quadrilaterals? You can find the answer before I say it, try to reach the result using the knowledge about triangles.”

After sufficient time is given, the groups meet. The previously drawn quadrilaterals are opened and a diagonal is drawn as below. It is shown that two triangles are formed, and it is reminded that the sum of the interior angles of the triangles is 180 degrees, and it is explained that 180 + 180 = 360 degrees because there are two triangles. In this case, it is tried to adopt the knowledge that the sum of the interior angles of any quadrilateral is 360 degrees.



Students are asked to draw 2 different quadrilaterals, show their diagonals, form triangles and show their angles.

The Wooden Frame (60 min)

The following framing problem is presented to the students.

When Aslı, Burak and their classmates start doing face-to-face lessons again, they decide to prepare a photo frame like the one below to hang in their classrooms.

The students who find enough wood material with a total circumference of 3 meters decide that the frame should be rectangular. But they can't decide which quadrilateral it will be.

After the problem is presented to the students, the following questions are asked in order. Questions B, c, d and e are done in groups of 2-3 people. One of the students shares his screen and it is ensured that they reach a solution together. In this process, the teacher constantly supports the groups by walking around. After giving them enough time to solve each question, the students gather and the teacher shares his screen, shows a few examples and asks the next question.

Help Aslı and her friends create the framework by answering the questions below.

a. What shapes can they use? (**math:2p)**

b. Burak thinks it will be easy to create a square, do you think? Can you create a square using the link https://blockly.games/turtle?lang=tr&level=1**? (math:2p, ICT: 3p/1p for loop, 2p for the correct coding)**

c. While creating a square, Asli does not want to make all the sides equal, but wants to create a rectangle. Create a rectangle using the link https://blockly.games/turtle?lang=tr&level=1. **(2p, ICT: 3p/1p for loop, 2p for the correct coding)**

D. Aslı and Burak's classmates decide to make a parallelogram and start as follows.

You decide how many degrees it should rotate in the next step and help the classmates create parallelograms by continuing their drawings at the link https://blockly.games/turtle?lang=tr&level=10. **(math:2p, ICT:4p/ 2p for loop, 2p for the correct coding)**

After all the questions are answered, the students gather and it is emphasized that the sum of the interior angles of the quadrilaterals must always be 360 degrees. After this explanation, students divide into groups again and solve the question in the textbook. The teacher supports the groups by visiting them. **(math:2p)**

Mathematical Reflections (30 min)

The address https://forms.gle/RZp1dpVadjsPr8p67 is shared with students. A minimum of 5 minutes is given. After the students answer the questions here, the teacher solves the textbook unit evaluation questions together with the students.

Week 5

Objectives:

M.5.2.3.1. Recognizes the units of length measurement; Converts meter-kilometer, meter-decimeter-centimeter-millimeter units and solves related problems.

M.5.2.3.2. Calculates the perimeters of triangles and quadrilaterals, creates different shapes with a given perimeter.

Length unit conversion (30 minutes)

(The images in this lesson are taken from the mathematics textbook.)

The teacher tells the students at the beginning of the lesson that length measurement units will be mentioned and conversions between units will be made in this lesson. The students are asked what the units of length measurement they know are. It makes use of the following sample questions that can be asked to students:

• What do you use to measure your height?

• What units are used to describe your height?

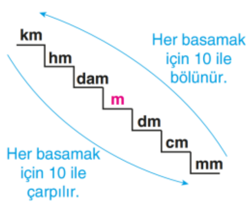
• What about when using the side lengths of your notebook?

• Do you think it makes sense to use centimeters when telling the distance between Aksaray and Ankara?

These questions can be increased according to the participation of the students. Then, it is stated that we use different units for different lengths, and apart from the units mentioned, other length measurement units that are newly learned and that we do not use frequently in daily life are mentioned and the unit table is presented to the students and they are expected to be written in the notebook.

Students watching the Transformers cartoon series are reminded of the transformation that took place there, the cars were turning into robots without any reduction or additional parts. The same will now happen between units of length measurement. We will make conversions between dimensions, their values will not change, but their images will change.

The students are reminded that 1 meter is 100 cm and asked how many millimeters are in 1 centimeter, reminding everyone to look at their rulers and reminding that the small lines in each centimeter are mm, the question of how many mm is repeated. When the students reach the equation “1 cm=10 mm”, the following image is shared with the students and the relationship between the units of length measurement based on division and multiplication by 10 is mentioned.



After the teacher explains and answers a few of the questions below, he waits for the students to do the rest, divides the students into groups of 2-3 and allows them to do group work. Each student writes these questions in his notebook, then when the groups gather, each group is given the right to speak and the questions are answered correctly.

<u>Questions:</u>

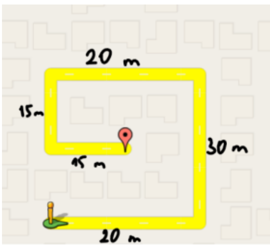
7 km	=	....	m	0,012 dm	=	....	mm
14 m	=	....	cm	310 mm	=	....	m
700 mm	=	....	cm	1071 m	=	....	km
3600 cm	=	....	m	9 cm	=	....	m
530 cm	=	....	mm	4300 dm	=	....	km
0,75 m	=	....	cm	120 m	=	....	km
12,3 km	=	....	m	8000 dm	=	....	km

Distances in the maze (30 minutes)

Reminding that it was used in the IT course on the Blockly website, the screenshots taken from the blockly puzzle I got lost in the labyrinth were edited and used in this activity.

The following problem is presented to the students by screen sharing and guided by the teacher, the students are expected to do it individually.

As you may remember from the Information Technologies and Software course, there was the puzzle "Lost in the Labyrinth" on the Blockly block-based coding page. Can you figure out how long the man in this maze has to walk to reach the goal shown below? **(2p)**



Students are then divided into groups of 2-3 and asked to solve the following questions in order. After the questions are solved, the groups send their solutions to the teacher, the class gathers, and the teacher finds the solutions together with the students.

• Yes, as you found, the whole road makes a total of 100 meters. Can you determine the representations of this distance in different units by making the following transformations? **(5p)**

o 100 meters = ……… dm

o 100 meters = ……… cm

o 100 meters = ………mm

o 100 meters = ………dam

o 100 meters = ……… hm

• The man in the labyrinth has a daily goal of 1 km for a healthy life. After walking the distance in this maze, how many more meters will he reach his goal? **(3p)**

• Let's get together in pairs, and one person from the group should write the algorithm until the roof in his labyrinth reaches the result, and the other person should convert this length between units. **(ICT: 10p)**

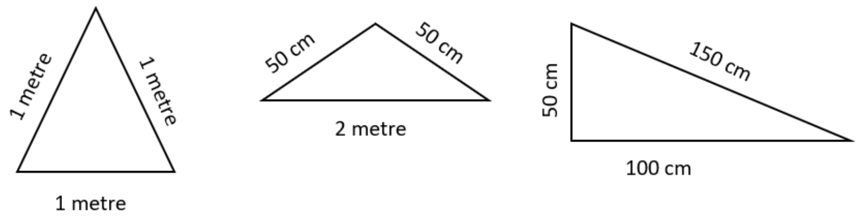
The Wooden Frame (30 minutes)

Referring to the wood frame problem of the previous week, the following problem is presented.

As you remember, last week, students wanted to create a frame for their classrooms with 3 meters of wood. Do you remember what shapes they were trying to make? Can you list what they've tried?

Students are expected to give answers of parallelogram, square, rectangle. The following explanation is then made. Students are expected to draw their triangles individually in their notebooks.

Yes, they tried to make these quadrilaterals, but if they tried to make triangles, they could form different triangles, right? In the examples below, I have drawn triangles with a perimeter of 3 meters.



As you can see, we can draw different triangles with the same perimeter. Can you draw a triangle with a perimeter of 3 meters like me? **(4p)**

After the students draw triangles in their notebooks, the teacher asks a few students from the class to show/say/draw the triangle they have drawn on the screen. Then he asks the following question, students form groups of 2-3 to solve the question.

The students, who think that it will not look very nice to make a triangular board, decide to make a quadrilateral again. But this time, they also try quadrilaterals that they haven't tried before, such as rhombus and trapezoid. Can you draw all these quadrilaterals with a perimeter of 3 meters? Try to use different side lengths than what you've drawn before. **(6p; 4p for correct perimeter and 2p for using different units)**

By sharing the screen within the group, the students take a screenshot of the rectangles they drew and the side lengths they determined and send them to their teachers. In the last 5 minutes of the lesson, the class is assembled, and a few examples are looked at together. The teacher emphasizes that different shapes can be drawn with the same perimeter and ends the lesson.

Race in the schoolyard (30 minutes)

The following question is presented to the students in order. After the students solve the first two parts of the question (items a and b) together with the teacher, they are divided into groups of 2 and are expected to do the rest of the questions. After all questions have been answered (about 15 minutes), the class is reconvened, and the answers are checked together.

When the schools opened, Aslı entered a competition with her classmates, competed with her friends to see who could run the farther distance in 20 minutes, and started running in the square school garden. At the end of the race, Aslı and her friends saw that they ran the amount indicated in the table below.

(10p; 2p for each question)

Aslı	2 rounds
Burak	1,5 rounds
Mehmet	2 rounds
Doruk	2,5 rounds
Ada	3 rounds
Nur	1 round

a) Who came first?

b) If the perimeter of the school garden is 200 meters, how many meters did the first person run?

c) How many meters did the last person run?

d) How many meters long is one side of the garden?

e) After the race was held, they told one of their classmates, Metin, who went to another city due to the pandemic, about the race on the phone, and Metin said, "I wish I was at school and raced with you." said. Then, if he records how many meters, he has run in 20 minutes, the class suggests that he can join our ranking. If Metin ran 550 meters in 20 minutes, what rank would he be in the class?

Mathematical Reflection (30 minutes)

https://forms.gle/8eto8u32GPf3cByC7 link is sent to students, approximately 10 minutes are given.

The first two questions of the end-of-the-top exercise, which consists of 6 questions on pages 240-241 of the mathematics textbook, are solved by sharing the screen by the teacher, the other four are expected to be solved by the students in groups of 2 and sent to the teacher.

APPENDIX R

CONSENT FORM

Araştırmayı destekleyen kurum: Boğaziçi Üniversitesi

Araştırmanın adı: Ortaokulda “öğrenme yayı” modeliyle Matematik ve BT kazanımlarını bütünleştirmenin problem çözmeye ve epistemolojik bakışa etkisi

Proje Yürütücüsü: Günizi Kartal

E-mail adresi:

Telefonu:

Araştırmacının adı: Dilek Turan

Adresi:

E-mail adresi:

Telefonu:

Değerli Veli ve Öğrenciler,

Eğitim Teknolojisi yüksek lisans öğrencisi olarak matematik ve bilişim teknolojileri derslerinde işlenen konular ve problem çözme başarısı üzerine bilimsel bir araştırma projesi yürütüyorum. 5. ve 6. sınıf öğrencilerini bu çalışmaya katılmaya davet ediyorum.

Proje konusu: Bu araştırma projesini konusu matematiğe bakış açısı, algoritmik düşünme becerisi ve matematiksel problem çözme becerisinin birbirleriyle olan ilişkisini anlamak ve öğrencilerin bu becerilerini artırmaktır.

Onam:

Araştırmaya katılmayı kabul ettiğiniz takdirde sizden kısa bir bilgi anketi ve Matematiğe bakış açınızla ilgili bir anket doldurmanızı isteyeceğim. Ayrıca sınıfta yaptığımız türden problem çözme sorularını cevaplamanızı isteyeceğim. Bu ölçekler toplam 30-40 dakikanızı alacaktır ve aynı ölçekler ünite sonunda tekrarlanacaktır.

Matematiğe bakış açınızı anlamak için verilecek olan anketi “Kesinlikle Katılıyorum (5), Katılıyorum (4), Kararsızım (3), Katılmıyorum (2) ve Kesinlikle Katılmıyorum (1)” seçeneklerinden birini işaretleyerek cevaplayacaksınız. Problem çözme sorularında ise çözümü bulup doğru şıkkı işaretlemeniz ya da yönergeye uygun şekilde çözümlerinizi yazmanız gerekiyor.

Bu araştırma bilimsel amaçla yapılmakta ve size herhangi bir risk getirmesi beklenmemektedir. Katılımcı bilgilerinin gizliliği esas tutulmaktadır. Anket, form ya da sınavlardaki isminiz ya da herhangi bir kişisel bilginiz benim haricimde kimse tarafından görülmeyecektir. Çalışma süresince elde edilen veriler yüksek lisans tezimde kullanılacaktır. Aynı veriler daha sonra bilimsel makale veya sunumlarda kullanılabilir. Burada da isminiz geçmeyecektir.

Katılım tamamen isteğe bağlıdır. Araştırmaya katılmadığınız takdirde ders notunuz olumsuz etkilenmeyecektir. Çalışmanın herhangi bir aşamasında herhangi bir sebep göstermeden çalışmadan çekilebilirsiniz. Çekildiğiniz takdirde ders notunuza olumsuz bir etkisi kesinlikle olmayacaktır. Eğer çalışmadan çekilirseniz, o ana kadar toplanan verileriniz kullanılmayacaktır.

Araştırma projesi hakkında ek bilgi almak isterseniz benimle ya da tez danışmanım Boğaziçi Üniversitesi Bilgisayar ve Öğretim Teknolojileri Bölümü Öğr. Üyesi Dr. Günizi Kartal ile temasa geçmekten çekinmeyiniz (e-posta: [redacted]. Ayrıca araştırma çalışması ile ilgili haklarınız konusunda Boğaziçi Üniversitesi Sosyal ve Beşeri Bilimler Yüksek Lisans ve Doktora Tezleri Etik İnceleme Komisyonu ile görüşebilirsiniz (e-posta [redacted])

Yukarıdaki açıklamaları okudum ve anladım. Çalışmaya katılmayı kabul ediyorum.

Katılımcı Adı-Soyadı: ………………………………….................................

İmzası: ………………………………………………

Tarih (gün/ay/yıl): ..../........../.............

VELİSİNİN Adı-Soyadı: ....

İmzası: ....

Tarih (gün/ay/yıl): ..../........../.............

Araştırmacının Adı- Soyadı: ....

İmzası: ....

Tarih (gün/ay/yıl): ...... / …… / ……

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