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Farklılaştırılmış Bilgisayar Destekli Matematik Etkinliklerinin Üstün Yetenekli Öğrencilerin Bilgi-İşlemsel Düşünme ve Matematiğe Yönelik Tutumlarına Etkisi***

The Effects of Differentiated Computer-Based Mathematical Activities on Gifted Students' Computational Thinking and Attitudes Toward Mathematics

ÖZ

Bu çalışmanın temel amacı, üstün yetenekli öğrencilere yönelik geliştirilen bilgisayar destekli matematik etkinliklerinin, bilgi-işlemsel düşünme becerilerine (yaratıcılık, algoritmik düşünme, işbirliklilik, eleştirel düşünme, problem çözme alt boyutlarıyla birlikte) ve matematiğe yönelik tutuma (ilgi, kaygı, çalışma, gereklilik gibi alt boyutlarıyla birlikte) etkisini araştırmaktır. "Ön test, son test deney-kontrol gruplu deneysel desen" kullanılmıştır. Araştırmanın örneklemini 22 üstün yetenekli öğrenci oluşturmaktadır. Bu öğrencilerden 11'i deney grubunda, diğer 11 öğrenci ise kontrol grubunda yer almaktadır. Veri toplama aracı olarak bilgi-işlemsel düşünme ve matematiğe yönelik tutum ölçeği kullanılmıştır. Nicel veriler analiz etmek için Mann-Whitney U testi ve Wilcoxon-Z testi kullanılmıştır. Deney ve kontrol grubunun bilgi-işlemsel düşünme becerilerinin yaratıcılık ve algoritmik düşünme boyutlarında anlamlı düzeyde farklılaştığı görülmüştür. Matematiğe yönelik tutumun alt boyutlarından çalışma ve gereksinim açısından anlamlı farklılık bulunmuştur. Bilgisayar tabanlı matematiksel etkinlikler, hesaplamalı düşünmenin yaratıcılık ve algoritmik düşünme boyutlarını olumlu yönde etkilemiştir. Bu etkinlikler matematiğe yönelik tutumun kaygı ve çalışma boyutlarını geliştirmiştir. Çalışmanın sonuçlarına göre bu etkinliklerin daha fazla geliştirilmesi ve yaygınlaştırılması gerektiği söylenebilir.
Anahtar Kelimeler: matematiğe yönelik tutum, bilgi-işlemsel düşünme, üstün yeteneklilik

ABSTRACT

The present study aims to investigate the effects of differentiated computer-based mathematical activities on computational thinking and attitude toward mathematics. "Pre-test, post-test experimental-control group design" was used. The sample of the study consists of 22 gifted students. Eleven students are in the experimental group; the other is in the control group. The computational thinking and attitude toward mathematics scale have been used as data collection tools. Mann-Whitney U test and Wilcoxon-Z test were used to analyze quantitative data. It was seen that the experimental and control group's computational thinking skills differed significantly in creativity and algorithmic thinking dimensions. There is a significant difference in attitude toward mathematics regarding study and requirements. Computer-based mathematical activities have positively affected the creativity and algorithmic thinking dimensions of computational thinking. These activities have improved the anxiety and study dimensions of the attitude toward mathematics. These activities should be developed more and disseminated.
Keywords: attitude toward mathematics, computational thinking, computer-based mathematical activities, giftedness

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*** Bu makale "Farklılaştırılmış Bilgisayar Destekli Matematik Etkinliklerinin Üstün Yeteneklilerin Bilgi İşlemsel Düşünme Özyeterlikleri ve Matematiğe Yönelik Tutumlarına Etkisi" başlıklı doktora tezinden üretilmiştir.

Introduction

Radical scientific developments occurred in the 19th and 20th centuries, and many inventions were introduced. Significant progress was accomplished in science, mathematics, and social sciences. Gifted individuals played an essential role in these developments (Porter, 2020; Roberts et al., 2022). These individuals' strong intuition, problem-solving abilities and creativity, critical perspectives, and algorithmic thinking abilities have paved the way for solving many complex problems.

Mathematics is accepted as an essential indicator of whether individuals are gifted (Assouline & Lupkowski-Shoplik, 2021). It is believed that children who are successful in mathematics will be successful in the future (Bildiren et al., 2020).

Giftedness is used to highlight human intelligence and analytical thinking skills. In the past, the concept of intelligence was used instead of superior ability, and this was closely related to IQ (Galton, 2019). British Galton was one of the first people to study intelligence. According to Galton, humans have a general mental ability, and information is transmitted to the brain by sense organs (Galton, 2019). Accordingly, there were differences in people's perceptions (Leaño, 2022). This condition was hereditary.

In the early 1900s, Spearman divided intelligence into two factors. These factors were the general factor (g factor), which is mental energy that plays a role in all kinds of activities, and the specific factor (s factor) that plays a role in certain activities (Spearman, 2010). Alfred Binet used the concepts of mental age and intelligence quotient in 1905 and developed the Binet test. Based on the Binet test, Terman developed the Intelligence Quotient Test (IQ-Test) in 1916 and created the Stanford-Binet (Binet, 1904). This test focused more on memory and analytical skills. Because according to Terman, intelligence was the ability to think about abstract phenomena (Binet, 1904). In the 1920s, Thorndike advocated the view that intelligence had different factors. Intelligence consisted of independent parts. Intelligence had three dimensions: abstract, social, and mechanical (Thorndike, 1898). In the 1930s, Thurstone put forward the view that intelligence consisted of abilities that required different mental powers. There were 12 intelligence factors: numerical, verbal, place-space relations, word fluency, reasoning, memory, perception, etc. (Thurstone, 1946). In the 1940s, Wechsler saw intelligence as the ability to cope with the environment with targeted thoughts and behaviors. Intelligence was the ability to understand the world, think, and use resources most efficiently and effectively in the face of difficulties (Wechsler, 1940). In the 1950s, Piaget argued that individuals of different ages adapted to the environment and developed through assimilation and regulation. Intelligence is the power of an individual to adjust to the environment (Piaget, 1952). Guilford introduced the Structure of the Intellect model. This model placed a strong emphasis on creativity (Guilford, 1950). Research carried out long ago by the Russian Vygotsyky in the 1960s resonated in America. Researchers such as Bruner, Hunt, Kagan, and Krech laid the foundations for understanding interactive intelligence (Stuart & Beste, 2011). In the 1980s and 1990s, Gardner proposed the theory of multiple intelligences. According to this theory, intelligence consists of linguistic, musical, logical-mathematical, spatial, bodily-kinesthetic, interpersonal, personal, and natural intelligence areas. Intelligence could not be explained by a single factor and consisted of many abilities (Gardner, 2010).

In short, the journey of giftedness, which started with analytical thinking, gradually expanded into a broader sense by covering general ability, unique academic ability, creative and critical thinking, leadership ability, natural intelligence, music, painting, etc. It evolved into giftedness by incorporating different skills, such as artistic abilities and social communication abilities (Conklin & Frei, 2007).

As mentioned in the related literature, while an intelligence-focused understanding was dominant in academic achievement and analytical thinking, this understanding evolved into the concept of talent by incorporating different factors. Gifted individuals became essential to acquire creativity, critical thinking, working collaboratively, algorithmic thinking, and solving problems (ISTE, 2015). These skills have come to the fore in recent years as sub-dimensions of computational thinking (Korkmaz et al., 2015).

Some researchers define the concept of computational thinking as the ability to use computers as a solution to problems encountered. However, this concept only fits into this concept today. Computational thinking is discussed in a broader framework. Computational thinking is the ability to use skills such as analysis, system design, problem-solving, data representation, modeling, binary search, iteration, and parallelization to face many problems that may be encountered in daily life (ISTE, 2015). It is essential to enable gifted students to acquire these skills (Sen et al., 2021).

One critical factor that increases the effectiveness and efficiency of mathematics lessons is the attitude towards this lesson since attitudes directly affect behaviors (Önal, 2013). Although gifted students have high attitudes toward mathematics, these attitudes are negatively affected by the pressure of environmental factors such as society, family, friends, teachers, and school. Önal (2013) mentioned the dimensions of interest, anxiety, study, and requirement within the scope of attitudes toward mathematics in his study. Based on these dimensions, this research deals with the change in the attitudes of gifted students in all aspects. Using information technologies in mathematics lessons for gifted individuals is insufficient, although they are employed in mathematics lessons in one way or another (Sen et al., 2021). Computer-based instruction can present subjects critically and logically with a creative perspective (Davis, 2021). In addition, skills such as problem-solving, collaborative work, and algorithmic thinking can be integrated into computer-based activities (ISTE, 2015).

1.1. Gifted Education

In gifted education, a suitable structure should be created in line with the needs determined by the characteristics of the children and the strengths and abilities arising from giftedness. Understanding gifted children's potential is essential (Edward, 2005).

Early childhood teachers must know that gifted children's experiences and worlds differ from their peers. Therefore, they need differentiated education. On the other hand, the basic principle of creating suitable environments for gifted children is to be aware of the need for special programs. For this reason, it is essential to identify and meet the unique needs of gifted children to use their potential.

There are many models for educating gifted children. The most striking of these in the literature is the differentiated curriculum. A differentiated curriculum expands the core curriculum and makes it suitable for gifted students' feelings, such as comprehension, discovery, and satisfaction (Samuels, 2005). One of the ways to achieve this is through rapid processing of the curriculum. The second is to give more in-depth information, facts, concepts, theories, and details. The third is complexity, called the topic context, which involves establishing inter-idea connections.

Another is that learners focus their unique approach on relevant individual studies to explain novelties and quirks (Kaplan, 1994).

1.2. Computer-Based Instruction

The most common form of using computers in learning-teaching processes is computer-based instruction. In this method, a computer is a teaching tool and an environment for learning. In computer-based instruction, the course contents are presented directly, the opportunity to repeat what has been learned is given, and problem-solving, practice, etc., activities are used (Alessi & Trollip, 2001).

In learning-teaching processes, computers are used in three ways: teaching the computer, instruction with a computer, and computer-based instruction. In teaching the computer, the computer itself is a teaching subject. Here, it is aimed to introduce and teach the computer. In instruction with a laptop, the teaching-learning processes are managed by computers. In this usage, the computer shows what needs to be done until each student acquires the behaviors intended by the teacher and keeps a record of what they do (Hong & Lee, 2022). In computer-based instruction, a computer is a teaching tool and an environment for learning.

1.3. Computational Thinking

ISTE (International Society for Technology in Education) (2015) defines computational thinking as a problem-solving approach that strengthens thinking by combining technology and thinking. Computational thinking is thinking analytically (Denning, 2022; Wing, 2008). According to another definition, computational thinking is solving problems according to people (Chevalier et al., 2020). It enables one to ask new questions and reach new answers easily by processing large amounts of information efficiently through metaphors (Kirçali & Özdener, 2022; Tang et al., 2020). ISTE (2015) explains computational thinking skills as a whole state of creative thinking, algorithmic thinking, critical thinking, problem-solving, cooperative learning, and communication skills.

1.4. Attitude Towards Mathematics

Today, mathematics is one of the fields where expectations from gifted students are high (Önal, 2013). Gifted students, such as family, school, friends, and teachers, are exposed to environmental pressure. They need to have a high attitude towards mathematics to overcome this pressure. Especially in the first years, the inability to build a healthy attitude creates negative attitudes toward mathematics in individuals. This situation is a relatively rare case for gifted students. However, the anxiety mentioned above about meeting the expectations stemming from environmental pressure may cause negative attitudes in gifted students. (Önal, 2013).

1.5. Aim of The Research

This study examines the effects of differentiated computer-based mathematics activities (CBMAs) prepared for gifted secondary school students on their computational thinking and attitudes toward mathematics.

In this direction, the research questions of the study are given below:

1. Is there a significant difference between the students' *computational thinking* in the experimental and control groups?
    a. Is there a significant difference in the *creative thinking* dimension?
    b. Is there a significant difference in the *algorithmic thinking* dimension?

   c. Is there a significant difference in the *collaborative thinking* dimension?
   d. Is there a significant difference in the *critical thinking* dimension?
   e. Is there a significant difference in the *problem-solving* dimension?
2. Is there a significant difference between the *attitudes* of students in the experimental and control groups toward mathematics?
   a. Is there a significant difference in the *interest* dimension?
   b. Is there a significant difference in the *anxiety* dimension?
   c. Is there a significant difference in the *study* dimension?
   d. Is there a significant difference in the *requirement* dimension?

1.6. Importance of The Research

When the studies on gifted students are examined, it is seen that the differentiation studies for the mathematics lesson are made, and the effects of various variables are discussed. However, there still needs to be more research regarding the importance of the education of gifted students. Information technologies are inevitably used in the education of gifted children, as in every field. From this point of view, this research employs differentiation studies for gifted learners using computer-based instruction. It is aimed that the data and comments that emerge as a result of this process will contribute to the development of computational thinking skills and attitudes toward mathematics.

It is seen that gifted students play an important role in following the developments in science and technology without delay and enabling countries to make further breakthroughs in the international arena. For this reason, it is understood that creativity, critical thinking, and problem-solving are the most essential skills gifted and formal students should possess. Although these skills are seen to be among the most critical skills that students should have, it is seen that research on these field-specific skills needs to be addressed (Borland, 2003; Colangelo & Davis, 2002).

This study employs computer-based activities for the differentiated educational needs of gifted students in mathematics lessons. These activities aim to increase the students' computational thinking skills and attitudes toward mathematics. These activities can be used as a resource in different schools. This approach can be adapted to other units in the coming years and can be used as a resource in the coming years. This research will likely be necessary in these aspects.

2. Method

2.1. Research Design

Quantitative methods were used in this study. In this research, "Pre-Test-Post-Test Experimental Control Group Design" was preferred among the full experimental designs. Experimental designs effectively establish causality between variables and determine causal linkages. This provides scientists with the chance to rigorously analyze the impact of an event or intervention on several outcomes.

2.2. Participant Group

Twenty-two gifted students in the 7th grade at Erzurum Remzi Sakaoğlu Science and Art Education Center (SAEC) participated in this research. These students were determined by exams for gifted students and taken to Science and Art Education centers. 19 male and three female students participated in the study. The students were randomly divided into two groups of 11 people. One group was assigned as the experimental group and the other as the control group.

2.3. Data Collection Techniques – Tools

This study collected quantitative data using the computational thinking skills and attitude scales toward mathematics. The "Computational Thinking Skill Levels Scale" prepared by Korkmaz, Çakır, & Özden (2015) to determine how the computer-based mathematics activities prepared in this study affected students' computational thinking skills was used with the researchers' permission. This scale consisted of five sub-dimensions (Figure 1).

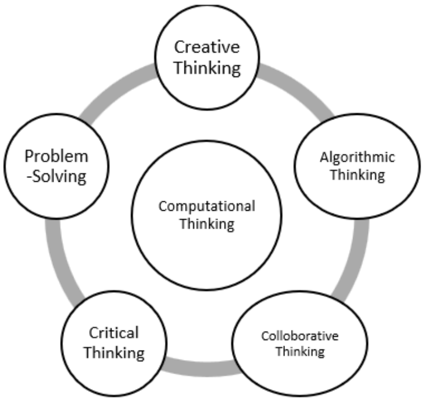

Figure 1. Computational Thinking and its sub-dimensions

With the researcher's permission, we used the "Middle School Students' Attitudes Towards Mathematics Scale" prepared by Önal in 2013 to examine the effect of the CBMAs on students' attitudes toward mathematics. This scale consisted of 22 items and four factors. These factors were interest, concern, requirement, and study.

2.4. Equivalence of experimental and control groups

In this section, it was examined whether the experimental and control groups were equivalent. For this purpose, the Mann-Whitney U test was performed. As a result of the statistical tests, it was concluded that the groups were comparable.

It was determined that there was no significant difference between the pre-test scores of the experimental and control groups in the dimensions of creativity, algorithmic thinking, collaboration, critical thinking, and problem-solving of computational thinking skills (Table 1) (p>05).

Creative Thinking	**N**	**MR**	**SR**	**U**	**Z**	**p**
Control Group	11	11,59	127,50	59,500	-0,068	0,946
Experimental Group	11	11,41	125,50			
Total	22					
Algorithmic Thinking						
Control Group	11	14,00	154,00	33,000	-1,838	0,066
Experimental Group	11	9,00	99,00			
Total	22					
Collaborative Thinking						
Control Group	11	13,68	150,50	36,500	-1,592	0,111
Experimental Group	11	9,32	102,50			
Total	22					

Critical Thinking						
Control Group	11	13,59	149,50	37,500	-1,518	0,129
Experimental Group	11	9,41	103,50			
Total	22					
Problem-Solving						
Control Group	11	13,32	146,50	40,500	-1,322	0,186
Experimental Group	11	9,68	106,50			
Total	22					

Table 1. Computational Thinking Mann Whitney-U pre-test results

The Mann-Whitney U test was applied to compare the pretest scores of the experimental group to which CBMAs were used for gifted students in the dimensions of interest, anxiety, study, and necessity, and the pretest scores of the control group were given in Table 2 (p>.05). Accordingly, the experimental and control groups are equivalent.

Interest Pre-test	N	MR	SR	U	Z	p
Control Group	11	13,77	151,50	35,500	-1,646	0,100
Experimental Group	11	9,23	101,50			
Total	22					
Anxiety Pre-Test						
Control Group	11	9,23	101,50	35,500	-1,659	0,097
Experimental Group	11	13,77	151,50			
Total	22					
Study Pre-Test						
Control Group	11	13,77	151,50	35,500	-1,678	0,101
Experimental Group	11	9,23	101,50			
Total	22					
Requirement Pre-Test						
Control Group	11	9,36	103,00	37,000	-1,564	0,118
Experimental Group	11	13,64	150,00			
Total	22					

Table 2. Attitude toward Mathematics Mann Whitney U pre-test results

2.5. Research Process

This study planned the process using the ASSURE instructional design model. This model consists of the stages of analyzing learners, state objectives, selection of educational environment and materials, utilizing educational environment and materials, requiring learner participation and evaluation-correction (Bajracharya, 2019).

Analyze Learners: At this stage, the characteristics of the learning audience, how they learn, learning speeds, etc., were analyzed. For this purpose, two mathematics teachers working in Erzurum Remzi Sakaoğlu SAEC, an administrator, a computer teacher, and a parent of gifted students, were interviewed. Their opinions were obtained about these characteristics of the students (Table 3).

Position/Profession	Age	Tenure of Office	Field
Manager	52	27	Guidance
Math teacher	39	10	Math
Math teacher	29	6	Math
Parent of student	46	-	-

Table 3. Demographic data of information providers

As a result of the interviews, it was concluded that the education to be given to gifted students using traditional methods would be boring. For this reason, it was concluded, considering the literature, that differentiating and enriching interventions were necessary among all the interventions that could be made for gifted students.

State Objectives: At the stage of determining the goals, differentiation and enrichment studies were carried out, considering the characteristics of gifted students. For this purpose, some of the gains in the curriculum were differentiated, and new acquisitions were added. Rational Numbers and Percentage units were selected from the 7th-grade units in this study. The reason for choosing these units was that the mathematics teachers working in SAECs stated that there needed to be more challenging activities to attract gifted students' attention in these subjects.

Select Media and Materials: In this study, two different environments were prepared for the experimental and control group students. While the experimental group was educated with computer-based mathematics activities developed by the researcher following the relevant acquisitions, the control group was educated with the traditional method (without any intervention). The two groups studied in the same class at different times. The experimental group of 11 people was divided into three groups. The control group students continued their regular education to avoid any intervention. SAECs were split into three groups in this group due to their periodic planning.

The activities in this study were prepared with the Wolfram Mathematica Program. In this study, the researcher developed computer-assisted mathematics activities by considering the items of the computational thinking scale and the differentiated and enriched state of the curriculum objectives. The mathematics teaching resources for four secondary school students used while preparing these activities are given in Table 4.

Source	Book Name
(Assouline & Lupkowski-Shoplik, 2021)	Developing math talent: A comprehensive guide to math education for gifted students in elementary and middle school
(Trouche et al., 2019)	The'resource'approach to Mathematics Education
(Van de Walle, Karen, & Bay-Williams, 2013)	Elementary and Middle School Mathematics Teaching Developmentally

Table 4. Mathematics Teaching Sources for Secondary School Students

The researcher prepared the Computer-Based Mathematical Activities (CBMAs). Three Computer and Instructional Technologies field experts and two mathematics education field experts reported their opinions on whether they were suitable for the scope of the present study. At the end of the process, some of the activities were removed, and some were rearranged in line with the opinions of field experts. Finally, new activities were designed in line with the views of field experts. The prepared activities had the characteristics of a dynamic, interactive object, and students could manipulate the variables. The activities were prepared at superficial, intermediate, and challenging levels. A section of these activities is presented in Figure 2. Each of the students in the experimental group was given a computer for this study. Students used the same computers throughout the activity.

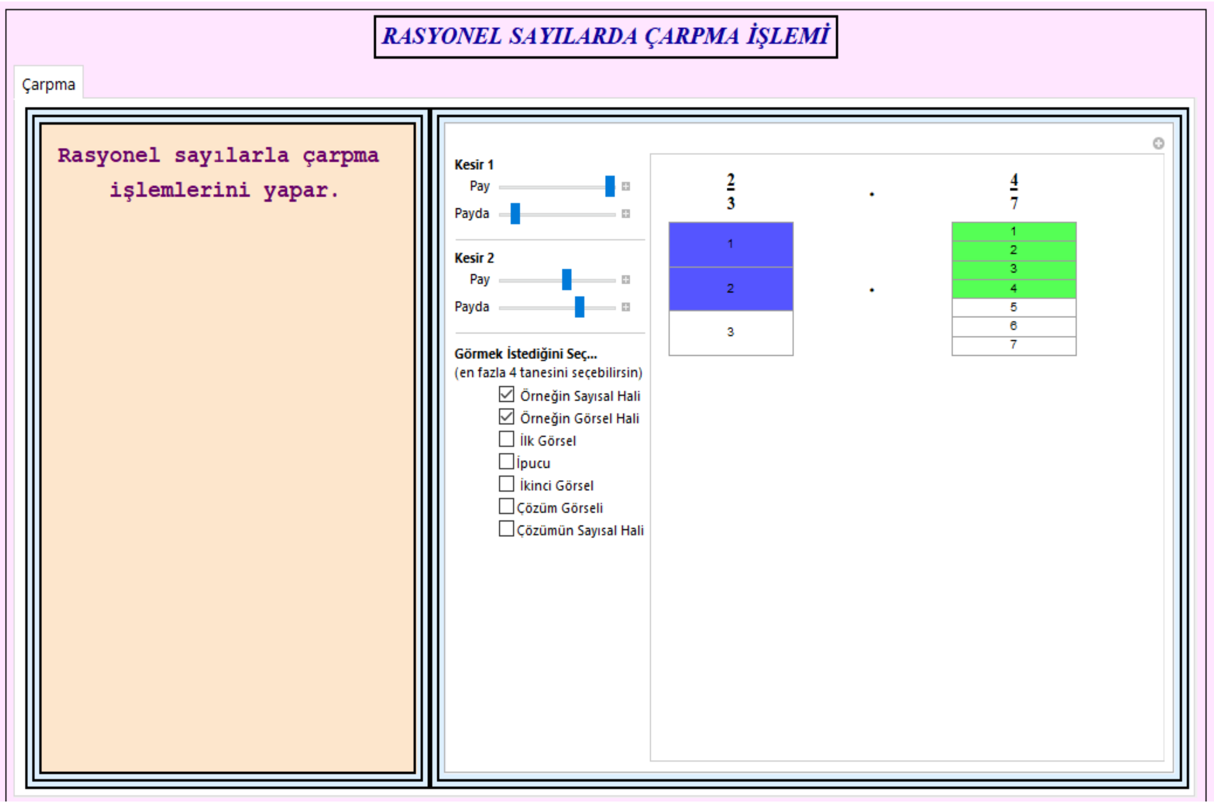

Figure 2. An example of a computer-based math activity

Utilize Media and Materials: At this stage, the prepared materials were applied in the classrooms of Remzi Sakaoğlu SAEC. The same instructor lectured both the experimental and control group students. Due to the individual characteristics of gifted students, the units were not instructed in detail. Since they had a certain pre-readiness, both traditional methods and computer-assisted teaching were directly processed with the activities.

The prepared activities were applied to one regular and two gifted students as a pilot. It was concluded that the students understood the activities and had no problem. As a result of the pilot application, the activities were implemented as five activities for four weeks. One week was reserved for the pre-test and one week for the post-test and interview. Thus, the process was completed in 6 weeks.

Require Learner Participation: Each of the students in the experimental group was given a laptop and asked to practice the activities. As a result of each activity, the teacher asked the learners questions about what the activity told and what the purpose could be. At the end of each activity, the learners expressed their opinions about the activities' purpose. The first three weeks of the implementation process were evaluated with individual activities, and the last week was arranged for cooperative activities. That week, the students carried out the activities in groups of three or four.

Evaluate and Revise: Field experts evaluated the activities in this study throughout the process; some were removed, some were revised, and we developed some new activities. With the pilot application, we tested the activities' feasibility, duration, and intelligibility and made the necessary arrangements. In addition, pre-tests and post-tests were conducted with the relevant scales to evaluate how these activities affected the students' level of computational thinking skills and their attitudes toward mathematics. The researcher assessed these data with statistical methods at the end of the process.

Data analysis: The researcher wanted to apply the Independent T-test and Repeated T-test parametric tests to the obtained data. However, since the data did not show normal distribution, the Mann-Whitney U test, the non-parametric equivalent of this test, was applied instead of the Independent T-test. The Wilcoxon-Z test, the non-parametric equivalent of this test, was used instead of the repeated T-test. The third research question was analyzed by using the content analysis method.

3. Results

3.1. Results of the Effect of CBMAs on Computational Thinking

Table 5 shows the Mann-Whitney U test data, which was applied to compare the post-test scores of the experimental group, in which CBMAs were used for gifted students in the dimensions of creativity, algorithmic thinking, collaboration, critical thinking, and problem-solving with the post-test scores of the control group.

Creative Thinking	**N**	**MR**	**SR**	**U**	**Z**	**P**
Control Group	11	6,27	69,00	43.500	-1.134	0,000
Experimental Group	11	16,73	184,00			
Total	22					
Algorithmic Thinking						
Control Group	11	7,00	77,00	11,000	-3,356	0,001
Experimental Group	11	16,00	176,00			
Total	22					
Collaborative Thinking						
Control Group	11	9,86	108,50	42,500	-1,232	0,218
Experimental Group	11	13,14	144,50			
Total	22					
Critical Thinking						
Control Group	11	12,50	137,50	49,500	-0,729	0,466
Experimental Group	11	10,50	115,50			
Total	22					
Problem-Solving						
Control Group	11	12,27	135,00	52,000	-0,567	0,571
Experimental Group	11	10,73	118,00			
Total	22					

*p<0.05 (significant) **Table 5.** Computational Thinking Mann Whitney U Post-Test Results

There is a statistically significant difference in the creative thinking dimension of the computational thinking skills of the experimental and control groups (U=43.500, z=-1.134, p>.05). According to these results, the average post-test average score in the creative thinking dimension of the experimental group's computational thinking skills is significantly higher than the post-test average of the control group. This result shows that CBMAs for gifted students have a more positive effect on computational thinking skills than methods not intervening in the creativity dimension. It was observed that there was a statistically significant difference in the dimension of algorithmic thinking (U=11.000, z=-3.356, p<.05). According to the results of the analysis, the post-test averages of the experimental group's computational thinking skills in the algorithmic thinking dimension were significantly higher than the control group. This result shows that the computational thinking skills of the CBMAs for gifted students have a more positive effect on the algorithmic thinking dimension than the conventional methods. There is no significant difference in other dimensions.

Wilcoxon Signed Ranks test was used to compare the pretest-posttest averages of the students in the control group for their computational thinking skills (Table 6). According to the results of this test, there was no significant difference in the pretest-posttest mean scores of the control group's computational thinking skills (z=.186, p>0.05). According to the results of the analysis, it is seen that the courses taught with the conventional method did not have any significant effect on the averages of the computational thinking skills of the control group.

Creative Thinking	**Ranks**	**N**	**MR**	**SR**	**Z**	**P**
Control Group Pre-Test/Post-Test	Negative Ranks	2	2,50	5,00	-1,186	,236
	Positive Ranks	4	4,00	16,00		
	Equal	5				
	Total	11				
Algorithmic Thinking						
Control Group Pre-Test/Post-Test	Negative Ranks	7	6,14	43,00	-1,642	,101
	Positive Ranks	3	4,00	12,00		
	Equal	1				
	Total	11				
Collaborative Thinking						
Control Group Pre-Test/Post-Test	Negative Ranks	5	7,40	37,00	-,982	,326
	Positive Ranks	5	3,60	18,00		
	Equal	1				
	Total	11				
Critical Thinking						
Control Group Pre-Test/Post-Test	Negative Ranks	3	5,00	15,00	-,176	,860
	Positive Ranks	4	3,25	13,00		
	Equal	4				
	Total	11				
Problem-Solving						
Control Group Pre-Test/Post-Test	Negative Ranks	5	3,80	19,00	-,141	,888
	Positive Ranks	3	5,67	17,00		
	Equal	3				
	Total	11				

Table 6. Control Group Group Wilcoxon Signed Ranks Test Results

Wilcoxon Signed Ranks test was used to compare the pretest-posttest averages of the students in the experimental group for their computational thinking skills (Table 7).

Creative Thinking	**Ranks**	**N**	**MR**	**SR**	**Z**	**P**
Experimental Group Pre-Test/Post-Test	Negative Ranks	0	,00	,00	-2,940	,003
	Positive Ranks	11	6,00	66,00		
	Equal	0				
	Total	11				
Algorithmic Thinking						
Experimental Group	Negative Ranks	0	,00	,00	-2,810	,005

Pre-Test/Post-Test	Positive Ranks	10	5,50	55,00		
	Equal	1				
	Total	11				
Collaborative Thinking						
Experimental Group	Negative Ranks	1	1,50	1,50	-2,313	,021
Pre-Test/Post-Test	Positive Ranks	7	4,93	34,50		
	Equal	3				
	Total	11				
Critical Thinking						
Experimental Group	Negative Ranks	2	2,50	5,00	-1,845	,065
Pre-Test/Post-Test	Positive Ranks	6	5,17	31,00		
	Equal	3				
	Total	11				
Problem-Solving						
Experimental Group	Negative Ranks	4	5,50	22,00	-,562	,574
Pre-Test/Post-Test	Positive Ranks	6	5,50	33,00		
	Equal	1				
	Total	11				

Table 7. Experimental Group Group Wilcoxon Signed Ranks Test Results

According to this test, the pretest-posttest averages of the experimental group's computational thinking skills in the creativity dimension were significantly different (z=-2.940, p<0.05). It is seen that the courses taught with CBMAs had a positive effect on the averages of the experimental group's computational thinking skills in the creative thinking dimension. There was a significant difference between the pretest-posttest averages in the algorithmic thinking dimension of the experimental group's computational thinking skills (z=-2.810, p<0.05). The courses taught with CBMAs positively affected the experimental group's average computational thinking skills in the algorithmic thinking dimension. It was found that there was a significant difference in terms of pretest-posttest averages in the collaborative dimension of the experimental group's computational thinking skills (z=-2.313, p<0.05). It is seen that the courses taught with CBMAs had a positive effect on the averages of the experimental group's computational thinking skills in the dimension of collaborative thinking. There is no significant difference in other dimensions.

3.2. Results on the Effect of CBMAs on Attitudes towards Mathematics

When the results of the Mann-Whitney U test, which was applied to compare the post-test scores of the attitudes in the anxiety dimension, were examined, it was observed that there was a statistically significant difference between the attitudes of the experimental and control groups in the anxiety dimension towards mathematics (U=4.500, z=-3.705, p<.05). It was observed that there was a statistically significant difference between the experimental and control groups' attitudes towards mathematics in the dimension of study (U=.50, z=-3.961, p<.05). There is no significant difference in other dimensions (Table 8).

Post-Test of Interest		**MR**	**SR**	**U**	**Z**	**P**
Control Group	11	14,00	154,00	33,000	-1,815	0,070
Experimental Group	11	9,00	99,00			
Total	22					
Post-Test of Anxiety						

Control Group	11	6,41	70,50	4,500	-3,705	0,000*
Experimental Group	11	16,59	182,50			
Total	22					
Post-Test of Study						
Control Group	11	6,05	66,50	0,500	-3,961	0,000
Experimental Group	11	16,95	186,50			
Total	22					
Post-Test of Requirement						
Control Group	11	13,05	143,50	43,500	-1,134	0,257
Experimental Group	11	9,95	109,50			
Total	22					

Table 8. Mann Whitney U post-test results

Wilcoxon Signed Ranks test was used to compare the pretest-posttest averages of the students in the control group towards the mathematics lesson (Table 9). According to the test results, there was no significant difference between the pretest-posttest mean scores of the control group's attitudes towards mathematics in the dimension of interest (z=-0.704, p<0.05). A significant difference was observed in the pretest-posttest mean scores of the control group's attitudes toward mathematics in the dimension of anxiety (z=-2.823, p<0.05). It is seen that the lessons taught with the conventional method positively affected the anxiety dimension of the control group towards the mathematics lesson. It was observed that there was no significant difference between the pretest-posttest mean scores of the control group's attitudes towards mathematics in the study dimension (z=-1.379, p>0.05). There is a significant difference in the pretest-posttest mean scores of the control group's attitudes toward mathematics in the requirement dimension (z=-2.940, p<0.05). It is seen that the lessons taught with the conventional method positively affected the attitudes of the control group towards the mathematics lesson in the dimension of necessity.

Dimension of Interest	**Ranks**	**N**	**MR**	**SR**	**Z**	**P**
Control Group	Negative Ranks	2	6,50	13,00	-0,704	0,481
Pre-Test/Post-Test	Positive Ranks	6	3,83	23,00		
	Equal	3				
	Total	11				
Dimension of Anxiety						
Control Group	Negative Ranks	0	,00	,00	-2,823	,005*
Pre-Test/Post-Test	Positive Ranks	10	5,50	55,00		
	Equal	1				
	Total	11				
Dimension of Study						
Control Group	Negative Ranks	6	5,67	34,00	-1,379	,168
Pre-Test/Post-Test	Positive Ranks	3	3,67	11,00		
	Equal	2				
	Total	11				
Dimension of Requirement						
Control Group	Negative Ranks	0	,00	,00	-2,940	,003*
Pre-Test/Post-Test	Positive Ranks	11	6,00	66,00		
	Equal	0				
	Total	11				

Table 9. Control Group Wilcoxon Signed Ranks Test Results

Wilcoxon Signed Ranks test was used to compare the pretest-posttest averages of the students in the experimental group in the mathematics course (Table 10). There was no significant difference between the test results and the pretest-posttest mean scores of the experimental group's attitudes toward mathematics in the dimension of interest (z=-0.205, p<0.05). There was a significant difference in the pretest-posttest mean scores of the experimental group's attitudes toward mathematics in the dimension of anxiety (z=-2.678, p<0.05). It is seen that the lessons taught with CBMAs positively affected the attitudes of the experimental group towards the mathematics lesson in the dimension of anxiety. It was observed that there was no significant difference between the pretest-posttest mean scores of the experimental group's attitudes towards mathematics in the study dimension (z=-2.971, p<0.05). It is seen that the lessons taught with CBMAs positively affected the attitudes of the experimental group towards the mathematics lesson in terms of study. It was observed that there was no significant difference between the pretest-posttest mean scores of the experimental group's attitudes towards mathematics in the dimension of necessity (z=-1.88, p>0.05). According to these findings, both the conventional method and the CBMAs prepared for gifted students did not affect the attitudes of these students in terms of interest in mathematics.

Dimension of Interest	**Ranks**	**N**	**MR**	**SR**	**Z**	**P**
Experimental Group	Negative Ranks	6	4,92	29,50	-0,205	0,837
Pre-Test/Post-Test	Positive Ranks	4	6,38	25,50		
	Equal	1				
	Total	11				
Dimension of Anxiety						
Control Group	Negative Ranks	1	3,00	3,00	-2,678	,007*
Pre-Test/Post-Test	Positive Ranks	10	6,30	63,00		
	Equal	0				
	Total	11				
Dimension of Study						
Experimental Group	Negative Ranks	0	,00	,00	-2,971	,003*
Pre-Test/Post-Test	Positive Ranks	11	6,00	66,00		
	Equal	0				
	Total	11				
Dimension of Requirement						
Experimental Group	Negative Ranks	3	3,00	9,00	-1,88	,059
Pre-Test/Post-Test	Positive Ranks	7	6,57	46,00		
	Equal	1				
	Total	11				

Table 10. Experimental Group Wilcoxon Signed Ranks Test Results

4. Discussion

4.1. Discussion on Computational Thinking

It can be concluded that the computational thinking skills of the CBMAs for the gifted in the creative thinking dimension have a more positive effect on the creativity dimension than the methods without intervention. The courses taught with the conventional approach do not significantly impact the averages of computational thinking skills in the creative thinking dimension.

According to Sternberg (1997), creativity covers advanced skills such as decision-making, reasoning, evaluation, memory, critical thinking, and problem-solving. Within the scope of this study, attention has been paid to the fact that the CBMAs prepared can provide these capabilities. In the activities designed, the ways and methods gifted students have yet to see before differ from their current knowledge. During the implementation process, the teacher needed to convey these ways directly, and the students were expected to find and explain these ways. With the visual modeling systems in the activities, it was anticipated that gifted students would solve the logic of the facts and operations. With these activities, students were encouraged to generate ideas. According to Sternberg and Lubart (1999), thinking that leads to results is a dimension of creativity. Practices such as reward and punishment in the learning process affect intrinsic motivation and prevent meaningful learning and creativity (Bundy, 2007). All these may be the reasons for the success of CBMAs in terms of creativity.

The results obtained in the creative thinking dimension are in excellent agreement with other studies in the literature. Looking at the literature, Considering the characteristics of gifted students, it is seen that most of the studies that differentiate them with appropriate approaches successfully influence the learners' creativity level positively. For example, mathematical modeling activities prepared within the scope of Kim et al.'s study in 2004 also positively affected students' creativity. Another study showing that mathematical units and activities designed for gifted students reflect on students' creativity is Özyaprak's (2012). Özyaprak increased students' creativity by using the units that differentiate according to gifted students in teaching.

Similarly, Dering and Davaslıgil (2020) used the differentiation approach in mathematics lessons and increased the creativity of gifted students. This situation is not different from other studies in the literature (Alhusaini, 2018; Kamarudin et al., 2022). Considering the successful results of all these studies, it can be said that the curricula, programs, units, and activities to be prepared for gifted students are essential in developing their creativity.

It is seen that the computational thinking skills of the CBMAs for the gifted have a more positive effect on the algorithmic thinking dimension than the conventional methods. It was concluded that the computational thinking skills of the courses taught with the continuous approach did not significantly affect the algorithmic thinking dimension.

In the activities prepared following the algorithmic thinking dimension in this research, Visuals describing the logic of events were given in stages, and students were expected to solve the algorithms in these models. This expectation may be the reason for the success of CBMAs in the dimension of algorithmic thinking.

It was concluded that the CBMAs for the gifted and the courses taught with the conventional method in the cooperative dimension of computational thinking skills did not significantly affect the averages of the computational thinking skills in the collaborative dimension.

There was no significant difference between the experimental group and the control group in terms of critical thinking. It can be said that both CBMAs and the conventional method had a similar effect on critical thinking.

According to Huitt (1998), the ability to think critically is not a skill that learners can acquire in one or more courses. Gaining this ability can be possible with a regular program. In addition, this program's continuity is essential for this skill's permanence. As a result of an insufficiently sustained program, learners may lose their ability to think critically over time. Accordingly, in this study, although CBMAs increased the effect on critical thinking, the insignificance of this effect may be due to a four-week implementation period. A few additional weeks of activity with CBMAs can significantly increase critical thinking. According to Patrick (1986), giving learners critical thinking enables them to think critically about similar issues and problems inside and outside the classroom. This allows the learner to think critically from a general point of view.

Looking at the literature, it can be said that the activities prepared for gifted students are effective in helping these students gain critical thinking skills (Ceylan, 2022; Karabey, 2010; Kettler & Hebda, 2022). CBMAs increased the critical thinking skills of the experimental group in parallel with the studies in the literature, but this increase was insufficient. Beyer (2001) mentioned the importance of problem-solving, inference, critical thinking skills, information processing, and reasoning.

In the dimension of problem-solving skills, both CBMAs and the conventional method did not significantly affect problem-solving skills. Pepkin (2004) and Tambunan (2019) stated that students could produce more different solutions in some activities than in other activities; It was observed that they could create more stepwise solutions. In this study, students showed similar behaviors in some activities. Gavin (2021) concluded that problem-solving activities were more effective in determining the difference in students' mathematical creativity. When other studies in the literature are considered, it is seen that interventions such as activities, programs, and differentiated units positively affect the problem-solving skills of gifted students (Abidin et al., 2021; Ford & Scott, 2021; Poulos & Mamona-Downs, 2018).

According to Van Tassel-Baska and Stambaugh (2008), critical thinking and problem-solving skills, which are high-level thinking skills, should be considered when preparing the curriculum for gifted students.

The sub-dimensions of computational thinking are not independent and have a complex and intricate form, which is interrelated. For example, Guilford and Hoepfher (1966) believe problem-solving and creativity are among the most difficult mental activities. They are based on creativity, innovation, and critical thinking skills. The problem-solving process is also creative and innovative, while innovative production is a problem-solving tool.

4.2. Discussion on attitude toward mathematics

The conventional method and the CBMAs prepared for the gifted did not affect these students' attitudes regarding interest in mathematics. This may be because gifted students are highly interested in mathematics due to their nature.

When the attitude towards mathematics is considered in the anxiety dimension, it is seen that both CBMAs and the conventional method significantly reduce anxiety. However, when the post-test results of CBMAs and the continuous process are compared, the effect is significant in favor of CBMAs. According to these results, it can be said that attitudes towards the mathematics of the gifted students taught with CBMAss are more positive in the sub-dimension of anxiety. Considering the effect of CBMAs' attitude towards mathematics on the study size, it is seen that there is a significant increase in the averages of gifted students in the experimental group. In this case, the prepared activities reflect positively on the study sub-dimension of the attitude toward mathematics.

It is seen that the lessons taught with the conventional method positively affected the attitudes of the control group towards the mathematics lesson in the dimension of necessity. Although it is seen that the courses taught with CBMAs increase their attitudes towards the mathematics course in the dimension of necessity, it is seen that this increase is not significant.

Students' beliefs about success and what they learn are valuable and essential and affect their attitudes (Caine & Caine, 1997). CBMAs have been prepared so students can learn, believe they can succeed, feel included in the environment, and realize their potential. For this purpose, a classroom environment where students could feel comfortable and the rules were not sharp was encouraged. The attitudes of gifted students towards lessons can be increased with thematic and integrative activities (Diezman & Watters, 2000). All these can explain the positive reflection of CBMAs on attitude.

When we look at the literature, differentiated activities, units, programs, etc., prepared for gifted students, it is seen that the interventions have a positive effect on students' attitudes (Kamarudin et al., 2022; Özyaprak, 2012; Siegle et al., 2020). Since it positively impacts three of the four sub-dimensions in CBMAs, it can be mentioned in parallel with the literature. Lee et al. (2015) emphasized that the students expressed a positive opinion about the activities prepared for gifted students and confirmed the generality of the literature.

Researchers such as Caine and Caine (1997) mentioned that differentiated and enriched interventions could increase attitude. This study parallels the literature with the result that CBMAs reflect positively on mentality.

Conclusion

This study examined the effect of CBMAs prepared for gifted students on computational thinking (with creativity, algorithmic thinking, collaboration, critical thinking, and problem-solving) and attitudes toward mathematics (interest, anxiety, study, and requirement dimensions). The results obtained in this study can be briefly summarized as follows:

- While CBMAs had a significantly positive effect on the creative thinking dimension of computational thinking, the conventional method did not have any significant effect.
- While CBMAs had a significant positive effect on the algorithmic thinking dimension of computational thinking, the conventional method did not have any significant effect.
- While CBMAs had a significantly positive effect on the collaborative dimension of computational thinking, the conventional method did not have any significant effect.
- Both CBMAs and the conventional method did not significantly affect the critical thinking dimension of computational thinking.
- Both CBMAs and the conventional method did not significantly affect the problem-solving dimension of computational thinking.
- Neither CBMAs nor conventional methods significantly affect the interest dimension of attitude toward mathematics.
- CBMAs significantly positively affected the anxiety dimension of the attitude toward mathematics compared to the conventional method.
- While CBMAs had a significantly positive effect on the study dimension of the attitude toward mathematics, the conventional method did not have any significant effect.
- Both CBMAs and the conventional method significantly affected the requirement dimension of the attitude toward mathematics.

As a result of this research, the following suggestions can be made for practice and future research.

Recommendations for practice

- Activities to be prepared for gifted students can be developed based on an instructional design model.
- While preparing the activities, the learners' characteristics should be considered.
- Science and Art Centers, which lead in executing gifted education, should use CBMAs activities effectively and efficiently.

Recommendations for future studies

- CBMAs studies that deal with subjects different from Rational Numbers and Percentages can be done.
- The collaborative thinking dimension can be considered, in which insufficient work exists in the literature.
- Sub-dimensions of attitude towards CBMAs-related mathematics can be examined.

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Katkı Oranı Beyanı

Yazarlar makaleye eşit oranda katkı sunmuşlardır.

Çatışma Beyanı

Makalenin yazarları, bu çalışma ile ilgili taraf olabilecek herhangi bir kişi ya da finansal ilişkileri bulunmadığını dolayısıyla herhangi bir çıkar çatışmasının olmadığını beyan eder.

Destek ve teşekkür

Çalışmada herhangi bir kurum ya da kuruluştan destek alınmamıştır.