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Examining 4th Grade Gifted and Non-Gifted Students Understanding Levels of Place Value

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ABSTRACT

The aim of this research is to reveal the understanding of dimensions and sub-dimensions of the place value in natural numbers of gifted and non-gifted students attending fourth grade. A mixed approach was adopted in the research. The research is quantitative in terms of revealing the levels of place value, counting, representing, naming, renaming, comparing and calculating the dimensions of the students and comparing the general mean score of both groups with the mean score for each dimension, and it is qualitative in terms of revealing the mistakes made in these dimensions. The study group of the research consists of 76 students diagnosed as gifted who attend four different SACs and 90 non-gifted fourth grade students attending in a regular school in town in the Central Anatolia Region. According to the findings obtained in the research, it was revealed that students with a diagnosis of giftedness could not reach the desired learning level in the count by 10 forward sub-dimension of the counting dimension of the place value. It was also revealed that they could not reach the desired learning level in the non-standard representation sub-dimension of the representation dimension. On the other hand the non-gifted students could not reach the desired learning level also in the division sub-dimension of the calculation dimension. It was concluded that students that are diagnosed as gifted had high success in terms of understanding the place value of natural numbers. For both groups of students, it can be said that they have difficulties in operations with non-standard representations, and they have difficulty in thinking differently because they are used to doing the questions by memorization and rules. Experimental studies can be carried out on the dimensions of the place value.

Keywords:
Primary education, fourth grade, dimensions of place value, gifted students, mathematics education

1. Introduction

Several definitions of math concepts are reported. But the most basic definition among them is that it is a science that examines the structures, properties and relations of forms, and numbers and quantities through deductive reasoning and devotes to branches such as arithmetic, geometry, and algebra (Püsküllüoğlu, 2003). Mathematics as science consists of a system formed in the mind compared with the visible systems. The reason for this is the absence of smell, hardness, color, and the inability to be perceived by the sensory organs; and therefore, mathematics is created entirely by reason (Baykul, 2002). Numbers are one of the fundamental concepts of this system, which is formed in the mind and is entirely abstract. The numbers represented as symbols employed in the written representation of the numbers, which are the basis of all operations, play an essential role in the function and development of mathematics because they are utilized to express nearly any value ranging from very small to very large numbers. The values expressed by the numbers differ according to the digit they are in.

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It is important to learn the concept of place value in primary school years, to display the numbers in a regular way, and to reach the correct result of mathematical operations. Place value refers to the value that the numbers take according to their position in the number. In other words, the place values of the numbers represent the value of that number. Nowadays, the decimal number system is widely used. Ten basic symbols in the range of 0–9 are called numbers in this system. This is called the 10-point system because the multiplicities can be expressed in groups of ten and the expansion of each number can be written as the powers of 10 (Billstein, Libeskind, & Lott, 2013; Demirtaş, 1986; Dinç-Artut, & Tarım, 2006; Hacısalihlioglu, Hacıyev, & Kalantarov, 2000; Rappaport, 1966; Skemp, 1993; Sovchik, 1989). The concept of place emerges as a result of the grouping process in question, and each number gains value based on the place it is in. Whereas the number to the right of a natural number represents the digits digit, the number to the left of this digit represents the tens digit formed by grouping the troops into decimals. Hundreds, thousands, and tens of thousands follow the places, respectively.

It can be said that it has a stronger sequential structure compared to other subjects in terms of the subjects included in the mathematics course. The necessity of establishing solid foundations on mathematical subjects and concepts at a young age and structuring appropriate educational experiences on mathematics education is emphasized in the associated literature (Şengül & Ekinöz, 2007; Tutak, et al., 2012). It is believed that this is the only method for students to learn the mathematical skills they will need throughout their academic life. It is not possible to say that the concept is taught completely without introducing any precondition of any mathematical concept. This fact is also taken into account in the teaching of number and place value concepts. More specifically, two-digit numbers can be taught before single-digit numbers; it is unthinkable that three-digit numbers can be taught before two-digit numbers. The objectives related to the teaching of the number and place value concepts have been addressed to continue until the end of secondary school in the primary and secondary school mathematics curriculum. These concepts are a prerequisite for a spiral course of mathematics (Paydar & Sarı, 2019; Rohrer, 2009). The concept of place is important for all mathematical operations.

The findings of the research on the concept of place value reveal that concept teaching takes a long time and that numerous problems were experienced in the education-training process of concept teaching. For example, Kamii and Joseph (1988) asked elementary school students the place value of the number of a two-digit number in their study. The researchers concluded that the participant students only considered the number value by ignoring the place value of the number in their stage of evaluation after observing that 33% of the students studying in the third grade at the end of the semester and 50% of the students studying in the fourth grade answered the question correctly.

Vareles and Becker (1997), who established a methodology for teaching the concept of place value, sought an answer to the question of whether students aged 7 and 10 can discriminate between place value and number value in their research. It was concluded that 96.5% had difficulty in distinguishing the place value concept and the number value concept even though the students who participated in the study had preliminary information about the place value concept as a result of the pretest applied. It was also concluded in this study that the information that the sum of the place values of the numbers in a multi-digit number is equal to the number is not well understood. The development of the concept of place value in students means that it is not only possible with the correct reading or correct representation of the numbers but also the correct analysis of the number.

Thompson (2000) stated that most students envision the concept of place value in their minds in their primary school years but continue to be confused about this for a long time. Jones and Thornton (1993) also stated in their study on place value that elementary school students studying in the United States, in general, did not learn the concept of place value effectively. These situations are one of the challenges faced by all primary school students in several countries. Dinç-Artut and Tarm (2006) conducted research on the concept of place value with 728 elementary students from the second, third, fourth, and fifth grades. The study concluded that the students have answered the questions about the concept of place value somehow correctly in general and at the level of all classes, but there were many issues regardless of the students' grade levels. It was found that the difficulties encountered in the subject did not make a significant difference in terms of the gender variable. Other studies on place value in the literature stress that the great majority of students' arithmetic errors are attributable to a lack of comprehension of the place value concept (Arslan, Yıldız, & Yavuz, 2011; Arslan &

Ubuz, 2014; Bowers, Cobb, & McClain, 1999; Carpenter, et al., 1982; Dinç-Artut & Tarım, 2006; Kaplan, 2008). These studies have revealed that primary and secondary school students have problems in understanding the concept of place value, performing other operations related to it, or developing algorithms related to these processes.

Rogers (2014) emphasized that there are deficiencies in the process of learning and teaching the place value. He stated that the structure and evaluations in the curriculum were insufficient in teaching the place value. He stated that students have a shallow understanding because place value is taught straightforwardly in schools. He studied the values in seven dimensions as counting, representing, naming, renaming, comparing, estimating, and calculating dimensions with his experimental study in third–sixth grades in this context. He suggested that six dimensions would be adequate to describe the place value by excluding the estimate dimension as a consequence of the experimental investigation.

The dimensions he (Rogers 2014) handled in the concept of place can be summarized as follows:

Counting: Counting with 10 and its multiples forward and backward to understand the place value in rhythmic counting.

Naming: Reading a number expressed in symbols and expressing a number written in writing with symbols (numbers).

Renaming: This includes the grouping and naming of multiplicities in different formats as usual or unusual (e.g., "2340" number is called "2 thousand, 3 hundred, 4 decade" on the basis of the usual digits, and "2 thousand, 2 hundred, 14 decade" can it also be referred to.)

Representation: The expression of numbers in proportional/standard and non-proportional/non-standard representations using a set of materials or manipulatives. For example, proportional/standard representations: base blocks of decimal, objects/shapes may be used in non-proportional/non-standard representations.

Comparison: This refers to comparing the numbers according to their size and smallness.

Calculation: Understanding the natural value digit system using four processing skills (e.g., if we multiply 28 by 10, it turns to 280, 300 + 15 = 315. If we divide 250 by 10, it is 25).

The gifted students, who are subjected to a different education program than the education programs prepared for students with normal development in our country, receive education in Science and Art Centers (SAC). Students are nominated for the SAC by their classroom teachers. Candidate students who pass the group screening exam are invited to the individual examination. Then students who are identified as gifted are registered in the SAC (Bildiren, 2018). In these educational institutions, separate education, enrichment, deepening, and acceleration models are used considering the course contents (MoNE, 2015; Yıldız, 2010). When the educational strategies of gifted students are examined, grouping, acceleration, enrichment, and mentoring training strategies are used (Sak, 2017). In SAC, activities that provide high-level thinking skills are included, and these activities are based on project production and development. The programs used in the education of gifted students aim to gain in-depth behavior in a discipline by using disciplinary and interdisciplinary approaches (Bildiren, 2018). Gifted people are defined as individuals with superior performance compared to their peers in one or more areas, who have a strong creativity aspect, can complete and overcome the project they started, and have extraordinary thinking and problem-solving abilities (Davis & Rimm, 2004; Gardner, 2011; Guilford, 1967; Özbay, 2013). Experts state that these students perform at a high level in intelligence, creativity, art, leadership, or special academic fields compared to their peers (MoNE, 2015). Some features in early childhood or school age can help us distinguish gifted children. These features are speaking in correct sentences in the ages of 1 and 2; starting reading and writing at 3 and 4 or earlier; simple arithmetic problem solving at the ages of 3 and 4 or younger; and adult-level performance in areas including painting, music, mathematics, and creative writing before the age of 10 (Sak, 2017). Students who are not identified as gifted differ from those who are non-gifted in terms of their characteristics, educational strategies, understanding, and perspectives. This difference requires examining the answers that gifted students give to the mathematical problems that are done in the usual and unusual mathematics lesson, as in other courses. The differences in the point of view, solution method, question perception, and the mistakes they make should be examined according to the students who are not recognized as gifted. Especially in the primary school age, which is a concrete operational period, knowing how gifted students use these skills and their difficulties may be important in terms of identifying these students and shaping their education programs more efficiently.

There is no study on the concept of place value for students who are determined to be gifted by experts in the literature review. Knowing the mistakes students make about the place value, which is the basis of the mathematics subjects in the curriculum, can make it easier for them to understand and grasp the next topics; it can contribute to taking necessary precautions in the teaching process. This research aims to reveal the primary school fourth-grade students' understanding of dimensions (counting, naming, renaming, representing, comparing, and calculating) and sub-dimensions of the place value in natural numbers who attend Science and Arts Center (SAC) and their peers who attend public school and to reveal whether students attending public schools differ from students who attend SAC.

Therefore, in this research, answers to the following questions were studied:

- Is there a difference between the general average scores of gifted and non-gifted students?
- Is there any difference between the average scores of gifted and non-gifted students for each of the counting, representing, naming, renaming, comparing, and calculating dimensions?
- What are the levels of gifted students of reaching the counting, representing, naming, renaming, comparing, calculating, and sub-dimensions and what are their mistakes?

2. Methodology

2.1. Research Model

The mixed method was used as a research method. The concurrent mixed method was chosen for the research of the mixed research methods. The research was performed as a quantitative study in terms of collecting data from the students who are gifted and non-gifted to reveal the level of reaching each sub-dimension of the value of the digits in natural numbers and the comparison of the general averages and the averages for each dimension of the students diagnosed who are gifted and non-gifted. The qualitative study was carried out to reveal the mistakes for each dimension for the students who are gifted and non-gifted.

In mixed-model studies, qualitative and quantitative data are used together to make multi-dimensional and more detailed examinations. The mixed method, which uses both qualitative and quantitative dimensions, can be used to examine the events and facts in more depth, as a whole, and in a richer framework (Yıldırım & Şimşek, 2016). The concurrent mixed pattern consists of a wide pattern of one or more types of data (either quantitative or qualitative or combined). Research data are collected and analyzed in traditional quantitative and qualitative patterns (Creswell, 2013; Teddlie & Tashakkori, 2015). In this study, when comparing the average achievement of students, a concurrent mixed pattern was preferred because the situation of gifted students was supported by qualitative data.

2.2. Research Sample

A total of 166 students participated in the study, including 76 fourth-grade students diagnosed as gifted and 90 fourth-grade students as non-gifted. Different sampling types were used when choosing the sample of the study. The study consisted of 90 students attending the fourth grade of a total of four public schools in the district center of a province in the Central Anatolia Region. Non-gifted students were selected from schools that researchers could easily access.

Seventy-six gifted students from four different SACs in different regions of Turkey were selected using a convenient sampling method. Büyüköztürk et al. (2011) stated that the main purpose of appropriate sampling method is to prevent loss of time, money, and labor. In the appropriate sampling method, the researcher continues to collect data starting from the most accessible responders to forming the sample until the research reaches the sampling size it needs. It was especially preferred that gifted students be from different regions of the country. Students who pass the science exam in SACs receive different trainings and those who enter from separate art (music and painting) fields. This study was conducted only with students who passed the science exam. Therefore, this study was carried out with a group that can be considered mathematically gifted. This study is limited to fourth-grade students who are gifted and non-gifted and the concept of place value.

2.3. Data Collection Tools and Procedures

The "natural numbers in the value test" developed by Paydar (2018) was used as a data collection tool in this study, which aims to reveal understanding in the dimensions and sub-dimensions of the place value in natural numbers for the status of the gifted students and non-gifted levels.

The reliability of the test consisting of 20 questions developed by Paydar (2018) was calculated as 0.88. In addition, the Cronbach alpha value for this study was calculated as 0.86. The suitability of the data collection tool for gifted fourth-grade students has been confirmed by a mathematics teacher who works at the SAC and also continues his doctorate education. In the measuring tool, there are questions including six dimensions of the place value and sub-dimensions of these dimensions. The scope of the current scale is expressed in Table 1.

Table 1. *Relevant Question Items Containing Dimensions and Sub-dimensions in the Measuring Tool*

Dimensions of the place value	Sub-dimensions of the place value	Question items
Counting	Counting Forward	1, 3
	Countdown	2, 4
Naming	Read	5
	Write	6
Renaming	Ordinary Expression	12, 13
	Extraordinary Expression	10, 11
Representing	Standard / Proportional Representation	7, 9
	From representation to number	8
Comparison	Big	14
	Between	15
Calculation	Small	16
	Addition	17
	Extraction	19
	Multiplication	20
	Division	18

Table 1 shows that the scale developed by Paydar (2018) has 20 items measuring all different dimensions and sub-dimensions. Items 1 and 3 measure the dimensions of counting numbers and tens forward, and items 2 and 4 measure counting down numbers and tens. The fifth item measures the reading sub-dimension of the naming dimension, and the sixth item measures the writing sub-dimension. Items 12 and 13 measure the sub-dimension of the renaming dimension, and items 10 and 11 measure the sub-dimension of the unconventional expression. Items 7 (from representation to number) and 9 (from number to representation) measure the standard/proportional representation sub-dimension and item 8 of the standard/non-proportional representations. The 14th item of the comparison dimension ranging from large to small is measured by item 14, the sub-dimension of finding the number between two numbers is the 15th item, and the lower order sorting dimension is the 16th item. The sum of the calculation dimension sub-dimension is the 17th item, subtraction sub-dimension is the 19th item, multiplication sub-dimension is the 20th item, and division process sub-dimension is the 18th item.

2.4. Data Analysis

Total scores were obtained by using the code 1 for each correct answer to the questions and 0 for each wrong and blank answer. The levels of gifted and non-gifted students for each dimension and sub-dimension are expressed as frequency and percentage. The size and level of reaching the sub-dimensions 75% were determined as a limit. Students who have reached 75% or above have been accepted as successful in the relevant dimension and sub-dimension. Özçelik (2010) stated that there is strong evidence showing that 75%–85% of the previous course's behavior should be learned in progressive courses. According to Baykul (2016), if a behavior was not acquired by 75% of the class, related behavior could not be learned in the class.

Independent groups *t* test was performed to compare the overall average achievement scores and the achievement scores of students attending SAC and public school for each dimension. The independent groups *t* test is a parametric test that tries to reveal the significance of the difference in the means of two independent samples at a selected probability level (Gay, Mills, & Airasian, 2012).

The content analysis method was used to analyze the errors of gifted students in each dimension and sub-dimension. It may not always be possible to directly observe, measure, and gain first-hand experience of human behavior. We can indirectly learn about human behavior through various communication methods with people using the content analysis method (Fraenkel et al., 2012). For the questions that include the sub-dimension of each dimension, the error types were determined separately by a classroom teacher and the field specialist. Comparisons were made between these two coders using the coherence formula of Miles and Huberman (reliability = consensus/consensus + disagreement × 100) (Miles & Huberman, 1994). The agreement ratio between the two encoders was obtained as 0.93. Then the types of errors with disagreement were evaluated together, and the final error types were determined. The types of errors previously identified in the literature are also added to the data analysis process.

2.5. Ethical

Ethics committee permission was obtained with the decision dated 22.04.2020 and numbered 2020-11/15 E. 16862 from the Social and Humanities Ethics Committee of Kahramanmaraş Sütçü Imam University before the data collection process.

3. Findings

In this section, the situation of the students about the place value is tried to be revealed with the place value test in line with the answers given by the fourth-grade students who are gifted and non-gifted. Findings obtained in this context are presented in line with sub-problems.

Findings Regarding the General Average Scores of Gifted and Non-Gifted Students

Within the scope of the first sub-problem of the research, Table 2 shows the results regarding the general average scores of gifted and non-gifted students.

Table 2. *The T-test Results Related to the Mean Value Test Average Scores of Gifted and Non-Gifted Students in Natural Numbers*

Student Type	N	M	SS	Sd	t	p
SAC	76	.8664	.099	164	11.848	.000
Public School	90	.5596	.220			

When the *t*-test results are examined, the average success value of the gifted students in natural numbers is 0.8664, and the standard deviation of this group is 0.099. The average achievement value of non-gifted students is 0.5596, and the standard deviation of this group is 0.220. The average value of the students' grade point value of gifted students is significantly higher than the average education level of non-gifted students, t (164) = 11.848; $p < 0.05$; $r^2 = 0.461$. It is seen that gifted students have higher success in place value than non-gifted students. Cohen (1988) stated that a significant difference with a high effect size (eta squared = 0.46) was found between the groups as a result of the independent sample *t* test.

Average Score Differences for Each Dimension of the Place Value of Gifted and Non-Gifted Students

Within the scope of the second sub-problem of the research, the findings regarding the difference between the mean scores of the non-gifted and gifted students for the natural numbers are counted; representing, naming, renaming, comparing, and calculating are tried to be revealed.

Average Score Differences in the Counting Dimension of the Place Value of Gifted and Non-Gifted Students

Table 3 shows the results regarding the mean score differences in the counting dimension of the place value of the students in both groups.

Table 3. *Average Score Differences in The Counting Dimension of the Place Value of the Students Who Gifted and Non-Gifted in Natural Numbers*

Student Type	N	$\bar{X}$	SS	Sd	t	p
SAC	76	.8454	.182	164	4.826	.000
Public School	90	.6778	.262			

When the *t*-test results are examined, the average success of the gifted students in the counting dimension of the place value in natural numbers is 0.8454, and the standard deviation of this group is 0.182. The average achievement in the counting dimension of the place value of the non-gifted students is 0.6778, and the standard deviation of this group is 0.262. The success rate of gifted students in the counting dimension of natural numbers is significantly higher than the average in the counting dimension of natural numbers of non-gifted students, t (164) = 4.826; $p < 0.05$; $r^2 = 0.12$. It is seen that the gifted students have higher achievements in the counting dimension in natural numbers than the non-gifted students. Cohen (1988) stated that a significant difference with a medium effect size (eta squared = 0.12) was found between the groups as a result of the independent sample *t* test.

The Average Score Differences in Representing the Place Value of Gifted and Non-Gifted Students

Table 4 shows the results regarding the mean score differences in the dimension of representing the place value of the students belonging to both groups.

Table 4. *Average Score Differences of the Gifted and Non-Gifted Students in the Representation Dimension of the Natural Numbers*

Student Type	N	M	SS	Sd	t	p
SAC	76	.7588	.240	164	8.485	.000
Public School	90	.3519	.371			

When the *t*-test results are examined, the average success of gifted students in representing the place value is 0.7588, and the standard deviation of this group is 0.240. The average achievement in representing the place value of non-gifted students is 0.3519, and the standard deviation of this group is 0.373. The success rate of gifted students in the representation dimension of natural numbers is significantly higher than the average in the representation dimension of natural numbers of non-gifted students, t (164) = 8.448; $p < 0.05$; $r^2 = 0.30$. It is seen that the success of gifted students in representing is higher than the non-gifted. Cohen (1988) stated that a significant difference with a high effect size (eta squared = 0.30) was found between the groups as a result of the independent sample *t* test.

Average Score Differences in the Renaming Dimension of Gifted and Non-Gifted Students

Table 5 shows the results regarding the mean score differences in the renaming dimension of the place value of the students belonging to both groups.

Table 5. *Average Score Differences in the Renaming Dimension of the Place Value of the Gifted and Non-Gifted Students*

Student Type	N	M	SS	Sd	t	p
SAC	76	.8914	.149	164	9.533	.000
Public School	90	.5333	.317			

When the *t*-test results are examined, the average success of gifted students in the renaming dimension of the place value is 0.8914, and the standard deviation of this group is 0.149. The average success of the non-gifted students in the renaming dimension of the place value is 0.5333, and the standard deviation of this group is 0.317. The average success rate of students that are gifted in the renaming dimension of the students that are non-gifted is significantly higher than the average success rate in the renaming dimension of students, t (164) = 9.533; $p < 0.05$; r^2=0.36. It is seen that the success of gifted students in renaming is higher than the non-gifted students. Cohen (1988) stated that a significant difference with a high effect size (eta squared = 0.36) was found between the groups as a result of the independent sample *t* test.

Average Score Differences in the Naming Dimension of Gifted and Non-Gifted Students

Table 6 shows the results regarding the mean score differences in the naming dimension of the natural values of the students belonging to both groups.

Table 6. *Average Score Differences in the Naming Dimension of the Natural Number of Gifted and Non-Gifted Students*

Student Type	N	M	SS	Sd	t	p
SAC	76	.9605	.135	164	3.026	.003
Public School	90	.8444	.332			

When the *t*-test results are examined, the average success of gifted students in the naming dimension of the place value is 0.9605, and the standard deviation of this group is 0.135. The average success of the non-gifted students in the naming dimension of the place value is 0.8444, and the standard deviation of this group is 0.332. The average success rate of the place value of giftedness students is significantly higher than the average success rate of the place value of the non-gifted students, t (164) = 8.448; $p < 0.05$; $r^2 = 0.05$. It is seen that the success of gifted students in the naming dimension is higher than gifted students. Cohen (1988) stated that a significant difference with a low effect size (eta squared = 0.05) was found between the groups as a result of the independent sample *t* test.

Average Score Differences in the Comparison Dimension of Gifted and Non-Gifted Students

Table 7 shows the results regarding the mean score differences in the comparison dimension of the place value of the students belonging to both groups.

Table 7. *Average Score Differences of Students Who Gifted and Non-Gifted in Comparison to the Natural Numbers in Terms of Their Place Value*

Student Type	N	M	SS	Sd	t	p
SAC	76	.9605	.108	164	7.380	.000
Public School	90	.7074	.303			

When the *t*-test results are examined, the average value of the gifted students is 0.9605, and the standard deviation of this group is 0.108. The average success of the students that are non-gifted in the comparison dimension of the place value is 0.7074, and the standard deviation of this group is 0.303. The average success of gifted students in the comparison dimension of the place value of non-gifted students is significantly higher than the average in the comparison value of the place value, t (164) = 7.380; $p < 0.05$; $r^2 = 0.24$. It is seen that the success of gifted students in comparison is higher than the students attending public school. Cohen (1988) stated that a significant difference with a medium effect size (eta squared = 0.24) was found between the groups as a result of the independent sample *t* test.

Average Score Differences in the Calculation Dimension of Gifted and Non-Gifted Students

Table 8 shows the results regarding the mean score differences in the calculation dimension of the place value of the students belonging to both groups.

Table 8. *Average Score Differences of the Students Who Gifted and Non-Gifted in the Natural Numbers in the Calculation Dimension of the Place Value*

Student Type	N	M	SS	Sd	t	p
SAC	76	.8224	.190	164	8.426	.000
Public School	90	.5222	.266			

When the *t*-test results are examined, the average success of gifted students in the calculation dimension of the place value is 0.8224, and the standard deviation of this group is 0.190. The average achievement in the calculation dimension of the place value of non-gifted students is 0.5222, and the standard deviation of this group is 0.266.

The average success rate of gifted students in the calculation dimension of the place value of non-gifted students is significantly higher than the average success rate in the calculation dimension, t (164) = 8.426; $p < 0.05$; $r^2 = 0.30$. It is seen that the success of gifted students in the calculation dimension is higher than the non-gifted students. Cohen (1988) stated that a significant difference with a high effect size (eta squared = 0.30) was found between the groups as a result of the independent sample t-test.

Reach Levels Regarding Dimension and Sub-Dimensions of Place Value and Errors

In this section, within the scope of the third sub-question, gifted and non-gifted students reach levels for each dimension and its sub-dimensions are determined. At the same time, the errors that gifted students made in each dimension and sub-dimension were analyzed.

Reaching Levels and Errors on Counting Dimension

Table 9 shows the achievement levels of the gifted and non-gifted students regarding the sub-dimensions of the counting dimension. The level of attaining achievements has been determined as 0.75 (Özçelik, 2010; Turgut & Baykul, 2014). In the placement test, if there is more than one item for a gain, the item with the highest level of attainment was taken.

Table 9 reveals that the fourth-grade gifted students have the desired learning level in the sub-dimensions of the counting dimension of the place value in natural numbers (94%), 1 counting back (84.2%), and 10 counting backs (96.1%).

Table 9. *The Levels of Reaching the Behaviors Related to the Sub-Dimensions of the "Counting" Dimension of Fourth Grade Gifted and Non-Gifted Students*

Sub dimensions	Gifted students correct		Gifted students wrong or no answer		Gifted students total		Non-gifted students correct		Non-gifted students wrong or no answer		Non-gifted students total	
	n	%	n	%	n	%	n	%	n	%	n	%
1) Counting forward	72	94,7	4	5,3	76	100	69	75,8	21	23,1	90	100
2) Counting down	44	84,2	12	15,8	76	100	81	89	9	9,9	90	100
3) Count by 10 forwards	48	63,2	28	36,8	76	100	28	30,8	62	68,1	90	100
4) Count by 10 down	73	96,1	3	3,9	76	100	66	72,5	24	26,4	90	100

Considering that 75% of the learning has to take place, it is seen that gifted students only do not reach the desired level of learning in the sub-dimension of the count by 10 forwards (63.2%). Non-gifted students, which is the desired learning level in counting forward sub-dimensions (75.8%) and counting down (89%). It is observed that they do not reach the desired level of learning in the sub-dimensions of 10 forward, 30.8%, and 10 counts (72.5%). Table 10 shows the errors of gifted students related to the sub-dimensions of the counting dimension.

Table 10. *The Mistakes Made by the Fourth-Grade Gifted students Regarding the Sub-Dimensions of the "Counting" Dimension to Understand the Place Value*

Sub dimensions	Questions	Error type	f	Error examples
Counting forward	How many more blocks are needed to complete 100 blocks to 1000?	1) Responding regardless of the multiplicity expressed by the given model	15	"10"
		2) Reducing the value of places to multiplicity	12	"900"
	What is the number after 9999?	3) Add unnecessary places while counting forward	2	"100000"
		4) Irrelevant answer to the question	2	"One million"
Counting down	What is the number before 1100?	1) Finding the next number instead of the previous number	3	"1101"
		2) Reducing unnecessary places from the number	2	"999"

When Table 10 is examined, 31 errors were made in the forward counting sub-dimension of the count value of natural numbers and 5 errors in the sub-dimension of the counting down. In the forward counting sub-dimension of the students, "responding regardless of the multiplicity given by the given model" 15, "reducing to the multi-place value" 12, adding unnecessary digits while counting forward 2, and "answering unrelated to the question" 2. In the countdown subscale, it is seen that students make the mistakes of "finding the next number instead of the previous number" 3 and "reducing unnecessary places from the number" 2.

Reaching Levels and Errors Made on Naming Dimension

Table 11 shows the levels of reaching the sub-dimensions of the naming dimension of gifted and non-gifted students.

Table 11. *Level of Reaching Behaviors Related to the Sub-Dimensions of the "Naming" Dimension of Fourth-Grade Gifted and Non-gifted Students*

Sub dimensions	Gifted students correct		Gifted students wrong or no answer		Gifted students total		Non-gifted students correct		Non-gifted students wrong or no answer		Non-gifted students total	
	n	%	n	%	n	%	n	%	n	%	n	%
Reading	72	94,7	4	5,3	76	100	76	84,4	14	15,6	90	100
Writing	72	97,4	4	5,3	76	100	76	84,4	14	15,6	90	100

Table 11 shows that fourth-grade students who are gifted reach the desired learning level 75% in the reading sub-dimension (94.7%) and the writing sub-dimension (97.4%) in the natural numbers. Likewise, it is seen that fourth-grade non-gifted students have reached the desired learning level in both the reading (84.4%) and writing (84.4%) sub-dimensions. Table 12 shows the errors of gifted students regarding the dimension of not naming sub-dimensions.

Table 12. *The Errors Made by the Fourth-Grade Students that are Gifted Regarding the Sub-dimensions of the "Naming" Dimension to Grasp the Place Value*

Sub dimensions	Questions	Error type	f	Error examples
1) Reading (Reading number)	Write the reading of the number 1005.	Ignoring zero's placeholding	1	"105"
2) Writing (Symbolizing verbal expression)	Write the number "four thousand seven hundred three" in numbers.	Ignoring zero's placeholding	1	"473"

When Table 12 is examined, it can be said that students made very few mistakes in the naming dimension of natural numbers. In both reading and writing subscales, the error of ignoring zero's placeholding 1 was made.

Reaching Levels and Errors Regarding the Representation Dimension

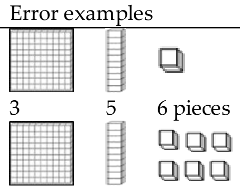
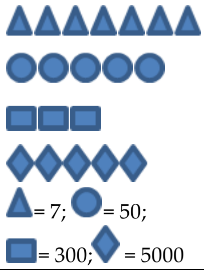
Table 13 shows reaching levels of students that are gifted and non-gifted regarding the subdimensions of the representation dimension. When Table 13 is examined, it is seen that the gifted students have reached the desired level of learning in the standard representation number (81.6%) and the standard/proportional representation (81%, in the standard representation number), which is both forms of the standard/proportional representation sub-dimension of the value of representing the place value in the natural numbers.

Table 13. *The Levels of Reaching Behaviors Related to the Sub-dimensions of the "Representation" Dimension of Fourth-Grade Gifted and Non-gifted Students*

Sub dimensions	Gifted students correct		Gifted students wrong or no answer		Gifted students total		Non-gifted students correct		Non-gifted students wrong or no answer		Non-gifted students total	
	n	%	n	%	n	%	n	%	n	%	n	%
1.Standard/ Proportional representation	62	81,6	14	18,4	76	100	27	30,0	63	70,0	90	100
2.Standard/ Proportional representation	62	81,6	14	18,4	76	100	30	33,3	60	66,7	90	100
3.Standard/ Non-proportional representation	49	64,5	27	35,5	76	100	38	42,2	52	57,8	90	100

In the sub-dimension of expressing the given expression with non-standard/proportional representations (64.5%), gifted students could not reach the desired level of learning. Expressing the standard/proportional representation sub-dimension of the representation value of the place value in natural numbers of non-gifted students (30%), expressing the number with a standard/proportional representation (33.3%), and expressing the given expression with non-standard/proportional representations (42.3%), it is observed that they do not reach the desired level of learning in their sub-dimensions. Table 14 shows the errors related to the sub-dimensions of the representation dimension of the gifted students.

Table 14. *The Errors Made by the Fourth-Grade Students that are Gifted Regarding the Sub-dimensions of the "Represent" Dimension to Grasp the Place Value*

Sub dimensions	Questions	Error types	f	Error examples
Standard/ proportional representation	Draw the model expressed by the number 356 using the hundreds, tens, and ones number blocks.	1)Writing the number values of the representations	5	
		2) Drawing missing representations	5	
		3) Not using representation	1	"3 hundreds, 5 tenner and 6 ones"
Non-standard, non-proportional representation	Show the number 5357 by drawing it with the given symbols. Ones =  Tenner =  Hundred =  Thousand = 	1) Drawing the place expressed by the representations in a complex order regardless of place value	14	
		2) Writing the place value of the representations	5	

Students that are gifted made 30 errors in the sub-dimension of representing the value of the place value in natural numbers with standard representations. While students expressed the numbers with standard representations, they made the mistakes of "writing number values of representations" 5, "drawing missing representations" 5, "unable to sort representations" 4, and "not using representation" 1. While expressing standard/proportional representations by numbers, "not being able to grasp the place of zero" 9, "misprinting symbols" 1, "use of zero in the wrong place" 1, "not taking into account all representations" 1, and "irrelevant answering" 3 errors were made. In the sub-dimension of expressing with standard/non-proportional representations, students made 22 mistakes. These errors are "drawing the digits expressed in complex order regardless of their digits" 14, "writing the place value of the symbols" 5, "writing the numerical value of the symbols" 2, and "drawing missing representations" 1. Some examples of errors are not included in Table 14.

Reaching Levels and Errors Made About the Renaming Dimension

Table 15 shows the levels of reaching the sub-dimensions of the renaming dimension of students that are gifted and non-gifted.

Table 15. *The Levels of Achieving Behaviors related to the Sub-dimensions of the "Rename" Dimension of Fourth-Grade Students that are Gifted and Non-gifted*

Sub dimensions	Gifted students correct		Gifted students wrong or no answer		Gifted students total		Non-gifted students correct		Non-gifted students wrong or no answer		Non-gifted students total	
	n	%	n	%	n	%	n	%	n	%	n	%
1)Expressing in the unusual way	65	85,5	11	14,5	76	100	57	62,6	33	36,3	90	100
2) Expressing in the unusual way	58	76,3	18	13,7	76	100	28	30,8	62	68,1	90	100
3) Expressing in the usual way	76	100	0	0	76	100	55	60,4	35	38,5	90	100
4) Expressing in the usual way	72	94,7	4	5,3	76	100	16	17,6	74	81,3	90	100

When Table 15 is examined, students that are gifted have reached the desired learning level of 75% in both questions (85.5% and 76.3%) of the sub-dimension of expressing the expression given in the renaming dimension of the place value unusually. In the sub-dimension of expressing the given expression differently, the students achieved the desired learning level in both questions (100% and 94.7%). Non-gifted students, on the other hand, were asked both in both questions (62.6% and 30.8%) of the sub-dimension of expressing the expression given in the renaming dimension (62.6% and 30.8%), and both questions (60% and 17.6%) could not reach the desired learning level of 75%. Table 16 shows the errors related to the sub-dimensions of the renaming dimension of gifted students.

Table 16. *The Errors Made by the Fourth-Grade Gifted Students Regarding the Sub-dimensions of the "Rename" Dimension to Understand the place Value*

Sub dimensions	Questions	Error type	f	Error examples
Usual way	Which number represents 8 thousand + 7 tens + 3 ones?	Inability to realize that zero is a placeholder	4	"873"
Unusual way	1) 1 hundred, 6 tens, 7 ones makes: ……. tens ……… ones?	1) Failure to convert the expression corresponding to the verbal expression other than usual into a different expression	23	"167 tens 167 ones" "6 tens 7 ones"
	2) How many 100 ₺ is in 1200 ₺? Write and explain your answer.	2) Finding the numbers wrong by doing irrelevant / invalid transactions	6	"1200/100=121"

Gifted students that have not been able to realize that the renaming dimension of the place value in natural numbers are "unable to comprehend that zero is a placeholder in the sub-dimension of expressing the given expression in the usual way" 4. In the sub-dimension of expressing the given expression unconventionally, they made the error of "not being able to convert the expression corresponding to the unusual expression to a different expression" 23 and "finding the result wrong by making irrelevant/invalid transactions given" 6.

Reaching Levels and Mistakes Made in Comparison Dimension

Table 17 shows the achievement levels of gifted and non-gifted students regarding the sub-dimensions of the comparison dimension.

Table 17. *The Levels of Reaching the Behaviors Related to the Sub-dimensions of the "Comparison" Dimension of Fourth-Grade Students that are Gifted and Non-gifted*

Sub dimensions	Gifted students correct		Gifted students wrong or no answer		Gifted students total		Non-gifted students correct		Non-gifted students wrong or no answer		Non-gifted students total	
	n	%	n	%	n	%	n	%	n	%	n	%
1) Big	73	96,1	3	3,9	76	100	69	75,8	21	23,1	90	100
2) Between	74	97,4	2	2,6	76	100	45	49,5	45	49,5	90	100
3) Small	72	94,7	4	5,3	76	100	77	84,6	13	14,3	90	100

When Table 17 is analyzed, gifted students reached 75%, which is the desired level of learning, in all of the dimensions (94.7%). Their scores of comparison value of the places in natural numbers to "sort the numbers given from large to small" (96.1%), "find the number between the two numbers given" (97.4%), and "sort the numbers given from small to large." On the other hand, students that are non-gifted reach the desired level of learning in the sub-dimensions of "ranking the numbers given from large to small" (75.8%) and "sorting the numbers given from small to large" (84.6%), but they did not reach the desired level of learning under the sub-dimension of "finding the number between two numbers" (49.5%). Table 18 shows the errors of gifted students regarding the sub-dimensions of the comparison dimension.

Table 18. *The Errors Made by the Fourth-Grade Gifted Students Regarding the Sub-dimensions of the "Comparison" Dimension to Grasp the Value of the Place*

Sub dimensions	Questions	Error type	f	Error examples
Small	30400, 34000, 30404, 30004 Write the numbers given above in descending order.	Failure to sort the given numbers from small to large.	4	"30404,30400, 30004,34000"
Big	4800, 4080, 4000, 4008 Write the numbers given above from small to large.	Failure to sort the given numbers from large to small.	3	"4080<4800< 4008<4000"

When Table 18 is analyzed, it is seen that the gifted students make the errors of sorting given numbers from small to large 4 and sorting given numbers from small to large 3 in the comparison dimension of natural numbers.

Reaching Levels and Errors Related to the Calculation Dimension

Table 19 shows the achievement levels of gifted and non-gifted students regarding the sub-dimensions of the calculation dimension.

Table 19. *The Levels of Reaching the Behaviors Related to the Sub-dimensions of the "Comparison" Dimension of Fourth-Grade Students that are Gifted and Non-gifted*

Sub dimensions	Gifted students correct		Gifted students wrong or no answer		Gifted students total		Non-gifted students correct		Non-gifted student wrong or no answe		Non-gifted students total	
	n	%	n	%	n	%	n	%	n	%	n	%
Addition	75	98,7	1	1,3	76	100	85	90,1	8	8,8	90	100
Division	37	48,7	39	51,3	76	100	5	5,5	85	93,4	90	100
Subtraction	69	90,8	7	9,2	76	100	62	68,1	28	30,8	90	100
Multiply	69	90,8	7	9,2	76	100	52	57,1	38	41,8	90	100

When Table 19 is examined, the calculation dimension of the place value of the students that are gifted is "addition" (98.7%), "subtraction" (90.8%), and "multiplying" (90.8%). It was observed that they reached 75%, which is the desired level of learning, in its sub-dimensions. The students could not reach the desired level of learning in the sub-dimension of "division" (48.7%).

On the contrary, while the non-gifted students reach the desired level of learning under the sub-dimension of "addition" (90.1%), it was observed that they did not reach the desired level of learning under the sub-dimensions of "subtracting" (68.1%), "multiplication" (57.1%), and "division" (5.5%). Table 20 shows the errors of gifted students regarding the sub-dimensions of the calculation dimension.

Table 20. *The Errors Made by the Fourth-Grade Gifted students Regarding the Sub-dimensions of the "Calculation" Dimension to Grasp the Place Value*

Sub dimensions	Questions	Error type	f	Error examples
Addition	What is the result of the 3000 + 5 hundred collection process? Write your answer.	Adding the number to the wrong digit	1	"3000 + 5 = 3005"
Subtraction	400–27 =? Write your answer.	Not being able to break decimals	2	"400 − 27 = 363"
Multiply	With what number do I have to multiply the number 372 to get the number 37200? Write your answer.	Not being able to multiply a given number by ten and multiples of ten	5	"372 × 372 = 138084"
Division	4080:10 =? Write your answer. The result is what portion of the number 4080?	Failure to find the result of the operation and express the result in decimal	26	"4080 / 10 = 408, Namely one in a thousand"

When Table 20 is examined, gifted students made the error of "adding the number to the wrong digit" 1 in the sub-dimension of calculating the calculation dimension of the place value in natural numbers. In the sub-dimension of the subtraction process, the errors of "not being able to break decimal" 2 and "finding false results even though decimal breaking" 2 were made. In the sub-dimension of the multiplication process, the error of "not multiplying the given number by ten and its multiples" 5 was made. Dividing is the most common sub-dimension of the sub-dimension. In the sub-dimension of the division process, "not being able to find the process and expressing the result in decimal" 26, "forgetting the zero that is a placeholder in the dividing process" 7, "not being able to divide according to the given expression" 4, and "irrelevant answer" 1 errors were made. Some examples of errors are not included in Table 20.

4. Conclusion and Discussion

In the research, the levels of comprehension of the digits in the natural numbers of the gifted elementary school fourth-grade students diagnosed as gifted and non-gifted were examined according to dimensions. The levels of counting, representing, naming, renaming, comparing, calculating, and on the sub-dimensions on gifted students are higher than the non-gifted students. The reason for this difference in achievement can be considered as the deepened education of gifted students at SAC after public school. In addition, the fact that the general abilities of gifted students are higher than their peers may affect this situation. It is seen that only on the counting dimension does the non-gifted students have a higher level of reaching the countdown sub-dimension than the gifted students. The reason for this can be said to be lower because gifted students do not pay attention to this question fully. When we look at the general average of success in the dimensions of the place value of the students, the gifted students have significantly higher than the general achievement average of the non-gifted students. Considering the average of success for each dimension of the place value, it can be concluded that gifted students in all dimensions (counting, representing, naming, renaming, comparing, and calculating) are higher than the non-gifted students. In another study (Yıldız, et al., 2012), it was found that gifted students used more strategies when solving problems than those who were non-gifted; as in this study, gifted students had a higher level of success. The reason for this can be considered as providing differentiated, enriched, and deepened education to gifted students (Çetin & Doğan, 2018; Yıldız, 2010).

According to the answers given by the gifted students to the applied questions, it was seen that among all sub-dimensions of the place value, gifted students did not reach the desired learning level (75%) in only three sub-dimensions, while non-gifted students could not reach the desired learning level (75%) in 11 sub-dimensions. Both gifted students and non-gifted students were found to be unable to reach the desired learning level of 75% in the sub-dimension of counting ten advanced in the counting dimension, in the sub-dimension of representing the given expression with non-standard representations, and in the division sub-dimension of the calculation dimension. When the answers of the students in both groups were examined for the ten counting forward sub-dimension, it can be said that they could not reach the desired learning level, especially because the concept of place value was not understood. For both groups of students, it can be said that they have difficulties in operations with non-standard representations, and they have difficulty in thinking differently because they are used to doing the questions by memorization and rules. In their article entitled "The relationship between mathematical creativity and intelligence: a study on gifted and general education students," Kahveci and Akgul (2019) reported that students with IQs above 130 who attend a special program score higher on measures of mathematics creativity than people with IQs below 130 who attend general education schools. However, in this study, there was no significant difference between the two groups in terms of creativity. Additionally, it can be said that students have difficulties because of using zero as a placeholder in dividing and the decimal form is not understood.

In studies on place value, the results showed that students have difficulty in understanding this subject in the researches about place value (Tosun, 2011). The reason for the difficulties with the numbers is the place value (Arslan, Yıldız, & Yavuz, 2011). Although they know the place value of the students, they cannot fully construct the place value (Kaplan, 2008), and students have misconceptions about the place value (Dinç-Artut & Tarım, 2006). This research also revealed that students have some mistakes about the place value as in the results of the literature. There is no study in which gifted primary school students' value comprehension levels are evaluated according to their dimensions and sub-dimensions in the literature. Although there is no other research about the size and sub-dimensions of the place value, except for Paydar (2018)'s work in public schools, there are studies on the mistakes made about the place value. In the research, reducing the place value to the majority, ignoring the placeholding of zero, writing the numerical values of the representations, and drawing missing representations, especially non-standard representations, are drawn in a complex order; and the unusual representations cannot be created with the digit order, the result of the operation cannot be expressed as a decimal, and forgetting the placeholder zero in the compartment are the most common errors of gifted students. These errors are similar to the study results in previous literature (Bingölbali & Özmantar, 2015; Çite, 2016; Özmen, 2017; Paydar, 2018; Tosun, 2011). Gifted students made very few mistakes in sub-dimensions such as addition, subtraction, multiplication, reading and writing the number, and comparing numbers. In the researches in the literature, the results of the students' forgetting to add on the side number in the four transactions and not being able to break the decade (Önal, 2018; Özmen, 2017; Sidekli, Gökbulut, & Sayar, 2013) were the least common types of errors in this study. The fact that these types of errors mentioned in the literature are much less in the study shows that gifted students have better operational knowledge than non-gifted students. It is thought that these errors, which are rarely seen in students' answers, may be because of a lack of operational knowledge rather than a lack of operational information. In the light of all this information, when the students frequently making mistakes are examined, it can be said that their conceptual knowledge about the place value is weaker and the operational knowledge is stronger. In this situation, it can be said that students try to solve the questions by using the operational knowledge, but the mistakes are caused by the inadequacy of associating the conceptual knowledge (Bingölbali, Arslan, & Zembat, 2016). This finding is in line with the finding that the students' conceptual knowledge about place value is weaker in the study of Paydar and Sarı (2019). Bingölbali and Özmantar (2015) stated that students have difficulties in using the place value in relational use; Rogers (2014) stated that teaching strategies are used limitedly in teaching the place value subject, and the place value subject is covered superficially. One of the most error-made dimensions is the representation dimension. The fact that gifted students have weaker conceptual knowledge, especially having difficulties in establishing structure and relationship outside of the standard unit (as seen in the expression dimension with non-standard representations), may not be considered as a reason for not linking curriculum, teaching strategies, and conceptual and operational knowledge together. Although there are many mistakes in the expression with standard representations section, the number of errors with non-standard representations is higher. It was concluded that there were difficulties in representation and modeling with the studies conducted in similar research (Aztekin & Şener, 2015; Güneş, Gülçiçek, & Bağcı, 2004; İpek & Okumuş, 2012; Paydar, 2018; Tuna, Biber & Yurt, 2013). Studies have concluded that representations are effective in learning (Çiltaş & Muşlu, 2016; Pilten, Serin, & Işık, 2016). In his study, Özdemir (2008) concluded that teacher candidates had difficulty in establishing a relationship with the material and could not comprehend what the materials were used to make sense of mathematical concepts. Considering the error made about expression with standard representations, which we can consider as a semi-abstract form of place value, performing more in-depth, broad content and relational teaching activities can reduce the types of errors and reduce the number of errors in non-standard representations. After all, non-standard semi-abstract symbols and unusual, relational activities can be included. To minimize errors and contribute to the students' meaningful learning, it may be beneficial to provide enormously enriched and relational learning environments to minimize errors regarding the place value, which is a prerequisite for other subjects of mathematics. In the experimental study conducted on the development of place value comprehension of the third-grade students of primary school carried out by Mutlu and Sarı (2019), it was observed that computer-aided educational materials improved students' understanding of place value. Hendrawan and Nurkamilah (2020) concluded that elementary school second-grade students understand the concept of place value better with flash CS6 activities in their study. For this reason, it can be suggested to give the concept of place value to students with technology support especially in the first years of primary school.

In the study in which Paydar, Doğan, and Şahin (2019) examined the readiness levels of primary school first-grade students for natural numbers, it was observed that students had the necessary skills to prepare for counting, while they understand the concepts of natural numbers and place value as they got older. It is considered that when the conceptual and operational aspects of the step concept will be given to enrich these trainings to be given by taking into consideration their readiness according to the grade level and to make the step concept meaningful.

Houdement and Tempier (2018) stated that only the positions of the digits are specified regarding the place value, and the relationship between each digit of the number is neglected. They stated that primary school teachers are not aware of the effect of place value on mathematics education and that the core of teacher education is place value. They also stated that the place value makes the relationships among decimals, calculation, and measurement units are visible. Thanheiser and Melhuish (2019) stated that teachers are adept at using the rules of addition and subtraction, but they are unaware of the basic features that require understanding the base ten place value system. All these show that it would be beneficial to enrich the content of teacher training to understand the place value semantically.

5. Recommendations

According to these results, the following suggestions can be made for place values and sub-dimensions.

- ✓ It may be useful to teach all the dimensions of the place value relationally so that they can embody the place value teaching enough for the students and understand the meaning of the place value.

- ✓ Because students need to understand the concept of place value at an early age, education can be enriched especially with the help of technology-supported teaching processes.
- ✓ Experimental studies on counting, representing, naming, renaming, comparing, and calculating dimensions can be carried out while constructing students' concept of digits.
- ✓ By monitoring the teaching processes, studies can be conducted on the extent to which teachers reveal the opportunities for relational understanding.

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