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An Investigation into the Cognitive Developmental Stages and Scientific Reasoning Characteristics of Children Aged 7-11[1]

7-11 Yaş Arası Çocukların Bilişsel Gelişim Evreleri ve Bilimsel Akıl Yürütme Özelliklerinin İncelenmesi

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Abstract

Many countries have structured their educational systems based on Jean Piaget's stages of cognitive development. However, Piaget also emphasized that development is influenced by culture and that the age ranges for cognitive stages may vary across different cultural contexts. Therefore, it is essential to understand the developmental stages of children within a specific country before designing educational levels, developing instructional materials, or implementing teacher training programs. Otherwise, the quality and effectiveness of a country's educational system may be compromised. This study investigated the cognitive development stages and scientific reasoning characteristics of children aged 7 to 11. The sample consisted of 45 students, divided into five age groups. Data were collected through semi-structured interviews and observation forms. The interview questions were based on two thought experiments from the social sciences. A total of 90 interviews were conducted, and 765 responses were analyzed using a qualitative data analysis program. The results indicated that all age groups exhibited the four types of scientific reasoning—abductive, inductive, deductive, and hypothetico-deductive—in varying frequencies and proportions. Additionally, the preoperational stage was found to persist until age 9, and the absence of clear indicators of the concrete operational stage suggests that it may begin around that age. Based on these results, recommendations are provided for the structuring of educational practices.

Keywords: Cognitive development, Scientific reasoning, Social sciences, Thought experiments

Özet

Birçok ülke eğitim sistemlerini Jean Piaget tarafından geliştirilen bilişsel gelişim aşamalarına dayandırmıştır. Ancak Piaget, gelişimin kültürden etkilendiğini ve bilişsel gelişim yaş aralıklarının kültürler arasında farklılık gösterebileceğini de savunmaktadır. Bu nedenle, eğitim seviyelerini belirlemeden, eğitim materyallerini ve öğretmen eğitimi programlarını geliştirmeden önce bir ülkedeki çocukların gelişim aşamalarını bilmenin önemli olduğu düşünülmektedir. Aksi takdirde, o ülkenin eğitim sistemi olumsuz etkilenebilir. Bu nedenle, bu çalışmada 7-11 yaş arası çocukların bilimsel akıl yürütme ve bilişsel gelişim aşamalarına ilişkin özellikleri araştırılmıştır. Çalışma grubu, 7-11 yaşları arasında her yaş grubunda alt, orta ve yüksek sosyo-ekonomik düzeylerde bulunan üçer öğrenci olmak üzere toplam 45 öğrenciden oluşmaktadır. Veriler yarı yapılandırılmış görüşme ve gözlem formu kullanılarak toplanmıştır. Yarı yapılandırılmış görüşme formu, sosyal bilimlerde hazırlanan iki düşünce deneyine bağlı sorulardan oluşmuştur. Toplam 90 görüşme yapılmış ve 765 yanıt nitel veri analizi programı kullanılarak analiz edilmiştir. Sonuçlar, her yaş grubunun dört bilimsel akıl yürütme yöntemi (abdüktif, tümevarım, tümdengelim ve hipotetik-tümdengelim) özelliklerini

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değişen sayı ve oranlarda sergilediğini göstermiştir. Ayrıca, çalışma grubunda işlem öncesi dönemin 9 yaşına kadar devam ettiği ve somut işlemler dönemi özelliklerinin gözlenmediği, somut işlemler döneminin 9 yaş civarında başladığı görülmüştür. Çalışma grubundaki öğrenciler 11 yaşına kadar halen orta ve düşük düzeyde somut işlemler dönemi özellikleri gösterdikleri için soyut işlemler dönemi özelliklerinin başladığı yaşa ilişkin bilgi sağlanamamıştır.

Anahtar Kelimeler: Bilişsel gelişim, Bilimsel akıl yürütme, Düşünme deneyleri, Sosyal bilimler

1. Introduction

Developmental psychologists suggest that cognitive development is influenced by a wide range of factors. In addition to hereditary traits and biological maturation, social environment and cultural context also have an impact on development (Shayer & Adey, 1981; Kind & Osborne, 2017; Losike-Sedimo, 2018; Bağcıoğlu Ünver, 2015; Dasen, 2018; Dzainudin et al., 2018; Greenfield, 2018; Senemoğlu, 2018; Aydın, 2020; İnanç et al., 2020). Jean Piaget emphasized that developmental stages occur across cultures in a universal, invariant sequence. However, he also acknowledged that the age at which children enter and complete these stages may vary both between and within cultures (Inhelder & Piaget, 1958). It is widely believed that many countries have structured their educational systems based on Piaget's age-based cognitive developmental stages. For instance, it is not a coincidence that the typical age range for primary education is 6–12 years in many European countries (e.g., Spain, Belgium, Lithuania, Luxembourg, the Netherlands, Switzerland) (European Commission-EACEA, 2022), as well as in Japan (National Information Center Japan – NICJP, 2023) and the United States (U.S. Department of Education, 2023). According to Piaget, children in this age group are at the end of the preoperational stage, in the concrete operational stage (7-11 years), and transition to the formal operational stage (Piaget & Inhelder, 1969). The average primary school age in Turkey is between 5.5 and 9.5 years (European Commission-EACEA, 2022). It is assumed that children in this age range can progress from the middle of the preoperational stage to the middle of the Concrete operational stage (Piaget & Inhelder, 1969). Considering the similarities and differences between countries, we believe it would be inappropriate to determine educational levels, develop educational materials, and even offer teacher training programs without knowing the developmental stages of children. Shayer and Adey (1981) found that the most biologically gifted 12-year-old child was at the cognitive level of the average 18-year-old, while the least gifted child was at the cognitive level of the average 6-year-old. Thus, it has been shown that there is a "12-year difference" between biologically gifted 12-year-olds in terms of cognition. This suggests that children with preoperational, concrete operational, and abstract operational characteristics may learn in the same classroom. However, it is debatable whether educational systems are structured accordingly.

Piaget looked into the reasoning characteristics of children to determine the characteristics of their developmental stages (Piaget, 1928). A study based on Piaget's references to scientific reasoning characteristics determined according to cognitive developmental stages will make essential contributions to the field in revealing the validity of the above situation for children in different cultures. Therefore, we focused on a small study group to examine the situation in Turkey. Clinical interview method (Inhelder & Piaget, 1958) or classical paper-and-pencil tests (Lawson, 1978; Tobin & Capie, 1981; Tobin & Capie, 1981; Roadrangka et al., 1982; Drummond & Fischhoff, 2017) are used to examine and assess scientific reasoning. Another method in which scenarios are used to evaluate scientific reasoning is thought experiments (Lattery, 2001). Studies (Lawson, 1978; Tobin & Capie, 1981; Roadrangka et al., 1982; Zimmerman, 2000; Acar, 2013; Wilhelm et al., 2018; Stammen et al., 2018; Ateş, 2019; Tüysüz & Tüzün, 2020) through thought experiments are generally in the field of "science ."However, social sciences are as important as science in daily life for everyone (Ernst Mach,

1905/1976; Georgiou, 2005). Therefore, we believe that social science studies will contribute to the literature by examining the characteristics of scientific reasoning. This study used thought experiments prepared in the social sciences to examine the characteristics of scientific reasoning. We think that this study will pave the way for further research. The main research question is as follows:

What are the characteristics of the scientific reasoning and cognitive development stage of children aged 7-11 in social sciences?

Sub-questions:

What are the scientific reasoning characteristics of children aged 7-11 in social sciences?

What are the cognitive developmental characteristics of children aged 7-11 years?

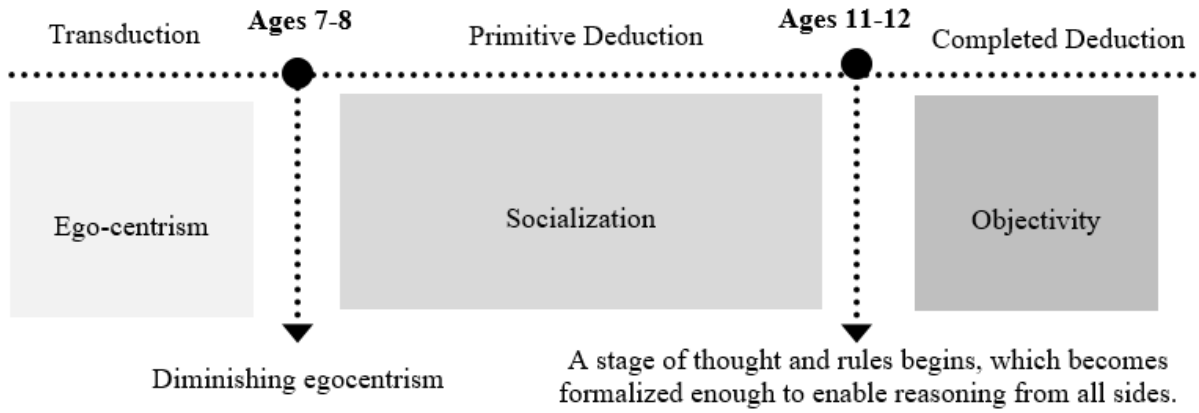
1.1. The Concept of Cognitive Development

Cognition reflects the mind and includes all mental activities, such as acquiring, understanding, and modifying information (Bjorklund, 2000). Cognitive development is how people learn to acquire, organize, and use knowledge (Gauvain & Richert, 2016). Bruner (1960) examined cognitive development by dividing it into three phases: actional, imaginative, and symbolic. He also argued that these phases occur in an invariable order. However, unlike Piaget, he emphasized that the emergence of the phases depends not on age but on the child's learning (Çeçen Eroğul, 2021). Vygotsky, on the other hand, talks about actual and possible developmental areas in his theory. According to him, there are differences between the actual and possible developmental zones. In the actual developmental zone, students can solve their problems freely. In the zone of possible development, students solve their problems with support. The difference is the child's "developmental space" (Wadsworth, 1975). Wadsworth (1975), who discusses the differences between Piaget and Vygotsky, states that he disagrees that Piaget's theory does not consider social and cultural factors and that Vygotsky fills the gap in Piaget's theory. In the next section, Piaget's theory of cognitive development and the characteristics of developmental stages will be presented in detail for this study.

1.1.1. Jean Piaget (1896-1980) and the Theory of Cognitive Development

Jean Piaget has had a greater impact on the short history of our science than any other theorist (Bjorklund, 2000). In his work, Piaget was not directly concerned with predicting behavior or teaching children, as many psychologists are. He preferred to be considered a genetic epistemologist (Wadsworth, 1975) and was interested in the empirical study of the development of knowledge (Bjorklund, 2000). Piaget explained the stages of cognitive development in terms of four basic sequential stages: Sensorimotor, Preoperational, Concrete Operational, and Formal Operational (Piaget & Inhelder, 1969). As in cognitive developmental theory, Piaget (1928) explained the stages of thinking in terms of ages before 7-8 years, between 7-8 years and 11-12 years, and 11-12 years and beyond. Piaget's stages of cognitive development include the preoperational stage before age 7-8, the concrete operational stage between ages 7-8 and 11-12, and the formal operational stage after age 11-12. Figure 1 shows these stages in detail.

Figure 1. *Stages of Reasoning According to Piaget's Cognitive Developmental Stages*



Source: Derived from Piaget's (1928) book titled "Judgment and Reasoning in the Child."

According to Piaget, children's thinking is transductive before the age of 7-8. Transduction is thinking that goes from specific to specific without generalization and logical necessity. During this stage, as soon as the child tries to generalize any explanation, he/she immediately falls into contradiction. Therefore, neither deductive nor inductive reasoning can be found. At 7-8, logical necessity appears with the decrease of egocentrism. That is, the child begins to feel the need to find reasons, evidence, conclusions, and explanations. Thus, transduction decreases due to the need for regular inductive and deductive reasoning. Children ages 7-8 to 11-12 exhibit childlike deductive reasoning. The first deductive work is done on premises derived from direct observation of reality. At the age of 11-12 and beyond, entirely deductive reasoning is observed with the development of formal thinking. Entirely deductive means drawing objective conclusions from a hypothetically accepted judgment, not from a fact obtained through unmediated observation or our subjective judgments (Piaget, 1928). To make the comparisons on this topic more understandable, the children's reasoning characteristics according to Piaget's stages of cognitive development are examined in detail in Table 1.

Table 1. *Characteristics of Cognitive Developmental Stages according to Piaget*

Age Range (Cognitive Developmental Stage)	**Characteristics**
Pre-7-8 Years (Preoperational Stage)	1. They relate everything to one another. 2. They connect two events/phenomena/thoughts instead of linking them. 3. They predict what might happen in the presence of certain conditions in phenomena, events, and situations and what happens according to results. 4. They make a causal explanation between two events/phenomena/thoughts. 5. In a semi-automatic way, they immediately come up with the necessary answer to the questions asked in events/phenomena/situations, but they cannot say how they act. 6. They insert new concepts of events/phenomena/situations into the old schema from an egocentric point of view. 7. They see each part as a whole.

Age Range (Cognitive Developmental Stage)	Characteristics
	8. They accept all situations/options simultaneously and fall into contradiction. 9. They reason from specific to specific. 10. They imitate the succession of events/phenomena/situations with gestures and imagination.
Age 7-8 and 11-12 (Concrete operational Stage)	1. They judge and reason about situations, events, and phenomena according to their own reality and beliefs. 2. In reasoning, they need to find reasons, evidence, conclusions, and explanations. 3. They try to connect two events/facts/thoughts or judgments logically. 4. When reasoning about events/phenomena/situations, their formalized thinking works only on isolated or specific cases rather than applying laws or general rules. 5. The first deductive ones are seen with logical "because." The reality of their deductions is based on their own construction of reality. 6. Their judgments are based on description and explanation. 7. Either they accept the data and do not see the absurdity in their inferences, or they reject the data as meaningless. 8. First logical definitions are observed to explain events/phenomena and situations. 9. There is a logic of belonging in event/fact/situation analysis. 10. They can think about comparing and finding relationships in the face of events/phenomena/situations.
11-12 Years and Older (Formal operational Stage)	1. They accept situations, events, and phenomena as data. 2. They do not touch objectivity, i.e., the characteristics of events/phenomena/situations.They remain in the plan of assumption presented in the event/situation and do not turn into an opinion or reality of their own in the process. 3. They generalize that consider antecedents and consequences in events/phenomena/situations. 4. They use general propositions/rules to compare events/phenomena/situations. 5. When they reason, they act according to the logic of relationships. 6. They resort to logical experimentation to become conscious of their processes for explaining events/phenomena/situations and to see whether they contain and contradict each other. 7. They use some concepts related to events/phenomena/situations in accordance with their meanings or give their full definitions. 8. They know that the parts represent a whole. 9. They conclude the judgments they reach deductively from the situation/premise and data they produce objectively. 10. They create objectively authentic situations/premises and data based on events/facts/situations.

According to Piaget, scientific thinking has different characteristics at different ages. Some characteristics develop gradually with age. This study analyzed the data related to the second subproblem using these characteristics.

1.2. The Concept of Scientific Reasoning

Scientific reasoning is defined as the deliberate pursuit of knowledge (Kuhn, 1996), the reasoning involved in generating, testing, and revising hypotheses or theories, including problem-solving skills and sharing the knowledge gained as a result of such research activities (Morris et al., 2012). Scientific reasoning can also be briefly defined as using scientific principles and methods to solve a problem (Zimmerman, 2005). In the process of scientific reasoning, theories are confronted with facts. One of the basic requirements of scientific reasoning is that facts support theories (Lakatos, 2014). As scientific knowledge changes over time, the standards set by philosophers of science for scientific knowledge also change (Demir, 2017). With the revolutionary changes that have been taking place in science for many years, scientific reasoning methods have also differentiated based on the philosophy of science. Information on scientific reasoning methods will be examined in detail in the next section.

1.2.1. Scientific Reasoning Methods and Features

There are several classifications of scientific reasoning methods. These are formal inductive and deductive methods, which are known as classical types of reasoning and have their counterparts in symbolic logic, and informal hypothetical deduction and retroduction methods, which have been introduced relatively recently and are considered within the framework of critical thinking (Hanson, 1958; Musgrave, 2009; Rothchild, 2006; Sprenger, 2011; Ateş, 2019). The scientific reasoning methods used in this study were categorized as formal and informal, covering all methods in all categories. Formal methods were identified as inductive and deductive, and informal methods were identified as abductive and hypothetical-deductive. When the studies from the literature review on scientific reasoning methods (Corcoran, 1989; Godfrey-Smith, 2003; Sarıtaş, 2012; Yıldırım, 2014; Yıldız & Aydemir, 2016; Ateş, 2019; Cramer-Petersen et al., 2019; Durhan, 2020; Çüçen, 2021; Emiroğlu, 2022) were examined, the general characteristics of the methods were summarized in Table 2, and the data related to the first subproblem of this study were analyzed using these characteristics.

Table 2. *Scientific Reasoning Methods and Features*

Scientific Reasoning Methods	Characteristics
Induction	• Based on symptoms, characteristics, observations, and experiences • Observation based on experience • Case-by-case examination • Reaching general judgments or propositions based on facts and experiences. • Going from the particular to the general • Producing knowledge through generalization.
Deduction	• Starting from apriori or evidential propositions • Obtaining particular propositions by filtering general propositions through the filter of reason • Going from the general to the particular. • Going from the whole to the part • Producing knowledge through proof.
Abduction	• Based on a limited set of observations or premises • Applied when there are few observations • Existing observations are accepted as premises • Reaching the most plausible/reasonable conclusion based on available observations • As a result, the pool of knowledge expands. • Results are valid for the current observation. They are not explanations for subsequent observations. • Widely used in daily life
Hypothetical Deduction	• Based on individual observations or phenomena and factual relationships that need to be explained • Hypotheses or theories are used at the conceptual level to explain observations, phenomena, or factual relationships. • Making logical or testable inferences from hypotheses or theories • Testing hypotheses by comparing inference, observation, and experimental data • The hypothesis is accepted or rejected according to the test results.

1.2.2. Evaluation of Scientific Reasoning

Scientific reasoning has been assessed in several studies using a variety of methods. Inhelder and Piaget (1958) studied children's scientific reasoning using the clinical interview method. Their study found that this method requires experience and is quite time-consuming. Piaget (2016) noted that this method was much more effective than the classic paper-and-pencil tests. However, when we look at today's research, we see that those assessments for paper-and-pencil studies (Lawson, 1978; Tobin & Capie, 1981; Roadrangka et al., 1982; Drummond & Fischhoff, 2017) are widely used because they are easy to use in a shorter amount of time. When paper-and-pencil tests are examined, it is found that the tests generally consist of items that are appropriate for the nature of science and mathematics. Using a multidisciplinary approach, Drummond and Fischhoff (2017) attempted to determine the level of scientific reasoning of individuals over 18 using a scientific reasoning scale they

developed. Another method that uses scenarios to assess scientific reasoning is thought experiments (Acar, 2013). Since thought experiments are one of the data collection tools used to assess scientific reasoning in this study, they will be examined in detail in the next section.

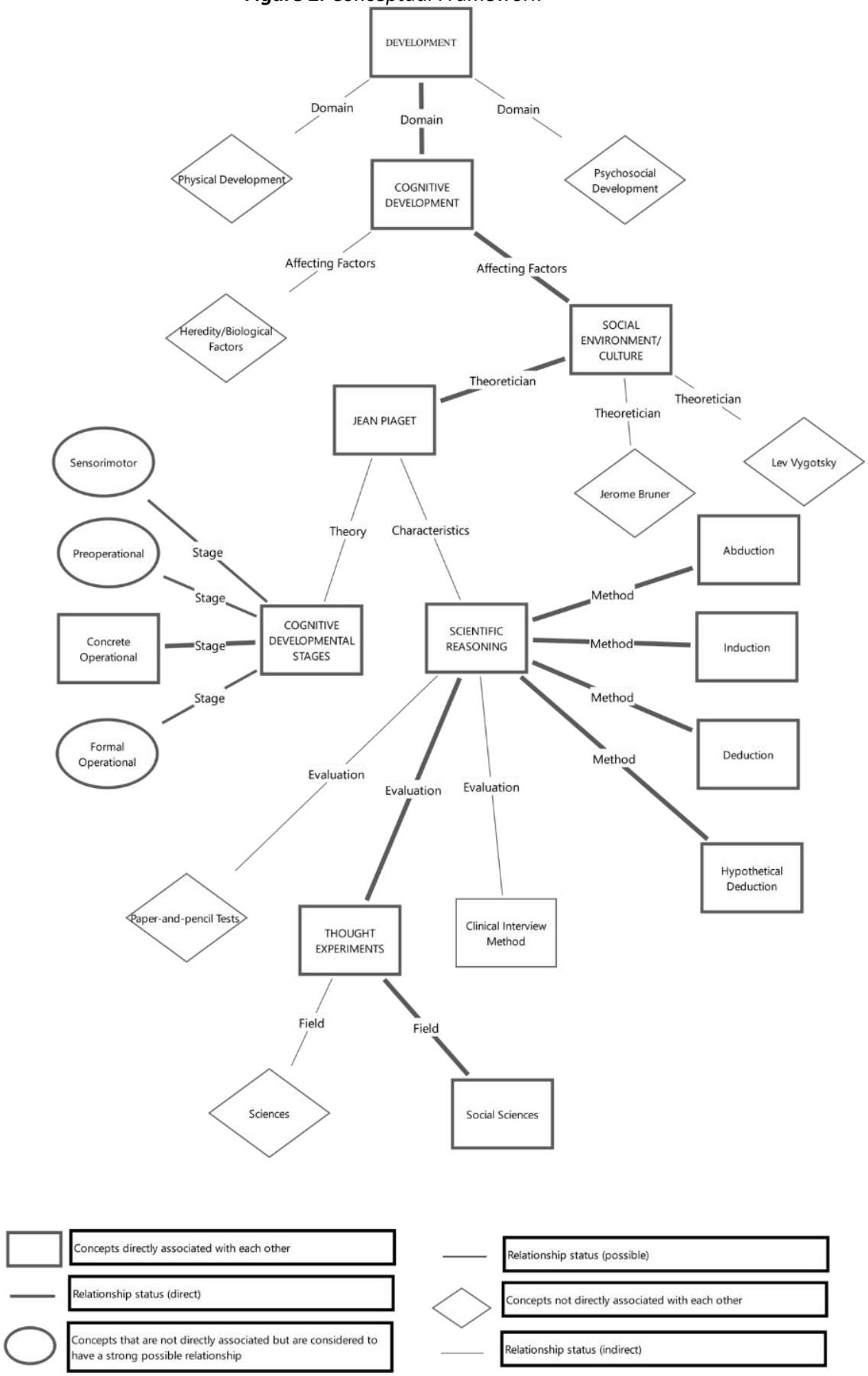
1.3. Thought Experiments

A thought experiment involves judging a given situation by considering the realization of fictionalized situations given in some scenarios (Gendler, 2000). Thought experiments attempt to conclude without application (Sorensen, 1992). All thought experiments share four main characteristics. The first is that the thought experiment takes place in the mind, the second is that it is based on a scenario, the third is that it involves hypothetical reasoning, and the fourth is that it seeks an answer to a scientific question (Ateş, 2015). Thought experiments are a tool that can contribute to students' learning by using their own experiences, developing their internal processes, and ensuring their active participation. Conducting a thought experiment allows students to think constructively, critically, and scientifically (Acar, 2013). Thought experiments have been used as mental tools in science and philosophy for a very long time (Ateş, 2015), and they play an important role in discussing scientific ideas and solving scientific problems (Lattery, 2001). If we examine the studies on thought experiments used as mental tools in science and their scientific reasoning properties, we can see that almost all studies (Klahr et al., 1993; Chen & Klahr, 1999; Acar, 2013; Wilhelm et al., 2018; Stammen et al., 2018; Tüysüz & Tüzün, 2020) are in the field of science such as physics and chemistry. However, Ernst Mach (1905/1976), one of the oldest representatives of the concept of thought experiments in history, stresses that thought experiments are critical not only in physics but in any field. Thought experiments are accepted as formal reasoning tools both in official discussions and in everyday life, even by critics (Georgiou, 2005). For this reason, we believe that thought experiments prepared in the natural sciences and social sciences will play an important role in observing and developing students' scientific reasoning characteristics in social studies courses or courses related to different subdisciplinary areas of the social sciences.

1.4. Conceptual Framework

Figure 2 shows the concepts within the theoretical foundations and the conceptual framework created to better understand the relationship between these concepts.

Figure 2. *Conceptual Framework*



This study investigated the scientific reasoning in social sciences of Turkish children of different ages in the concrete operational stage according to Piaget, and, thus, what cognitive developmental stage characteristics they show. For this purpose, the characteristics of children's scientific reasoning in social sciences were investigated in depth with the study group of 7-11-year-old students. The reason for selecting the 7-11-year-old children in the study group was to explain the characteristics of scientific reasoning in children considered to be at the same cognitive stage (concrete operational stage) but at different biological ages. The following section provides detailed information on the methodology of the study.

2. Method

We investigated the characteristics of children's scientific reasoning during the concrete operational stage across five age groups (7, 8, 9, 10, and 11 years) within the 7-11 age range and conducted comparative analyses across these groups. Accordingly, the research employed a holistic multiple-case design. In this design, each case is examined as a holistic entity, and individual cases are analyzed both independently and in comparison with one another (Yin, 2011).

2.1 Participants

Participants were recruited using purposive sampling, which was preferred to identify students between the ages of 7 and 11. Some criteria were determined by the purpose of the study because the fundamental understanding in purposive sampling design is to study all situations that meet a set of predetermined criteria (Gliner et al., 2009). These criteria are age, socio-cultural, cognitive development, and maximum diversity. In the first step of determining the study group, the school district with a sufficient number of students in the 7-11 age group at the lower, upper, and middle socio-cultural levels (SCL) was preferred. Since it was suitable for this characteristic, the students' teachers filled out a personal information form containing demographic information about the age and socio-cultural level of 7-11-year-old students attending public primary and secondary schools affiliated with the Ministry of National Education in Osmangazi district of Bursa province. Based on the data obtained from the personal information form, three students from each age group in three socio-cultural levels (Lower-Middle-Upper) were selected among the 7-11-year-old students in the concrete operational stage according to Piaget's cognitive development theory. The year and month of birth were used to determine the age of the students. To ensure maximum diversity, attention was paid to students who were seven years old and born at different stages of the same age. The age of the students was written as "7;3 for a child of 7 years and 3 months by giving the age and month together. The age level was defined as four levels. For example, for the age of 7 years, stage 1: (7;0), (7;1), (7;2), stage 2: (7;3), (7;4), (7;5), stage 3: (7;6), (7;7), (7;7), (7;8), and stage 4: (7;9), (7;10), (7;11). As a result, the study group consisted of 45 students, including three students from each age group and three students in the concrete operational stage at three socio-cultural levels. Three students from each age group and three socio-cultural levels were included. In addition, when forming the study group, care was taken to identify students from different age groups within an age stage and to ensure a homogeneous distribution of male and female students (23 boys, 22 girls).

2.2. Data Collection Process

The data collection process followed established qualitative research methodologies. Interview and observation methods were employed, as the primary aim was to examine and describe

the characteristics of scientific reasoning and cognitive developmental stages in children aged 7–11 within the social sciences. Semi-structured interviews were chosen (Fraenkel et al., 2012) to allow for an in-depth exploration of students' responses to the thought experiments. The interviews were audio-recorded and then transcribed into a written report by the researcher. A Voluntary Participation Form was obtained from both the children and their families for the interviews and audio recording, indicating that they voluntarily participated in this study. In addition, the study ethics committee permission was obtained.

A total of 90 interviews were conducted with 45 participants, each participating in two separate thought experiments. The experiments were administered on two consecutive weekdays for each participant—for example, Thought Experiment 1 on Monday and Thought Experiment 2 on Tuesday, or Thought Experiment 1 on Wednesday and Thought Experiment 2 on Thursday. No interviews were conducted at the end of the week, as the two-day weekend break following Friday could have disrupted continuity. The interviews took place during the second semester of the same academic year to ensure consistency and minimize potential disruptions for the participants. In addition to the researcher, an impartial observer was present throughout the data collection process. This observer remained the same throughout all interviews and also participated as an observer during the preliminary (pilot) application.

2.3. Data Collection Tools

This section includes data collection tools. Table 3 shows detailed information about the data collection tools.

Table 3. *Data Collection Tools*

Thought Experiments	Data Collection Tools
Thought Experiment 1	Interview Form
(World Class)	Observation Form (Checklist) and Notes
Thought Experiment 2 (Pandemic Migration)	Interview Form
	Observation Form (Checklist) and Notes

A data collection toolset was used. In the interviews, data were collected using two thought experiments. Semi-structured interviews were conducted with the participants. The researcher used a semi-structured interview form that included some questions about the thought experiments. During the semi-structured interviews, the researcher took observational notes. The researcher also prepared a "Scientific Reasoning Characteristics Observation Form (Checklist)" consisting of scientific reasoning characteristics and interview questions. Observation notes were also used as a data collection tool.

The thought experiment texts were created using student-level fonts and visuals. They were covered with laminating material to give the texts a write-erase feature. The researcher posed all questions. In addition, visuals such as maps were used in Thought Experiment 2, and these visuals were printed in A3 size at the highest quality and given to the students. The thought experiments consisted of three phases. Stage 1 (Free Time): The researcher gives the thought experiment text to the participants and observes the participants' reasoning while summarizing what is described in the text and asking questions about the text. Stage 2 (Enrichment): The researcher shares the data related to the thought experiments with the participants and expects them to reason according to that data.

Stage 3 Question-Answer: The researcher asks the participants semi-structured interview questions about thought experiments and expects them to reason on them.

Thought Experiment 1 and Thought Experiment 2 had the same phases. However, Thought Experiment 2 had different experimental texts and questions. In practice, there was only one difference from Thought Experiment 1. Thought experiment 2 is a thought experiment in the social science sub-discipline of geography. In the implementation of this experiment, at the end of the free time phase, before moving on to the enrichment phase, the researcher explained the three concepts given in the experiment text (population density, climatic conditions, and livelihoods) to all age groups of students through visuals, definitions, and maps using the same expressions. In addition, the students were given examples and asked to give examples. Then the enrichment step was started and the interview was concluded with a question and answer session.

2.4. Data Analysis

The data were analyzed using qualitative research data analysis methods. MAXQDA 2020 was used to analyze the qualitative data. Related visual tools were created with this program. The data were analyzed using the constant comparison analysis method. In this method the entire data set is read. Then the data is divided into smaller, meaningful pieces. Each piece is then given a descriptive title or "code." Each new piece of data is compared to other data. The data is then coded, and the codes are grouped according to similarity. Themes are identified and documented according to each grouping (Leech & Onwuegbuzie, 2007).

The data were analyzed in four steps. In the first step, a thematic framework was created according to the questions and characteristics in the interview and observation forms prior to data collection based on the theoretical basis of the research. In the second step, the data obtained from the interview and observation forms were organized according to the thematic framework using the MAXQDA 2020 program. The data to be directly quoted were determined. In the third step, the organized data were defined, and direct quotations were included. In the fourth step, the defined data were explained, associated, and compared between different phenomena.

The thematic framework was created in four stages in accordance with the theoretical basis of the research and the questions and features in the interview and observation forms. In the first stage, themes were prepared in accordance with the characteristics of scientific reasoning, which were defined and characterized within the framework of the theoretical basis of the research. In the second stage, codes were determined in accordance with the sub-features of the themes determined in the first stage. In the third step, codes and themes were matched according to the characteristics given in the theoretical framework. In the fourth step, for each question in the semi-structured interview form, a list of possible answers was prepared in accordance with each code, and thus with the theme, regarding the thought experiments asked of the students in the interviews.

2.5. Data Validity and Reliability

Prolonged interaction for credibility, in-depth focused data collection, triangulation of data collection methods, and expert review were used to ensure the internal validity of qualitative data. The researcher and the observer gained experience by conducting 24 interviews in the preliminary application of the experiments before the study. For the deep-focused data collection study, the researcher tried to reveal patterns by constantly comparing, interpreting, and conceptualizing the data obtained from one scenario for the other. For this reason, scenario situations prepared in different disciplinary fields were preferred to obtain valid data interpretation results. In addition, different data

collection methods, such as interviews and observations, were preferred in the study to provide methodological diversity. In this study, the research was reviewed in different dimensions by people who had general knowledge about the research topic and specialized in qualitative research methods. The researcher initially prepared seven thought experiments, but the number was reduced to four thought experiments considering the richness of the data. The four thought experiments prepared in the sub-disciplinary fields of social sciences, the observation form for scientific reasoning characteristics, the specification table prepared for the experiments and observation form, and the tagline of the thesis were sent to experts in the field, and general opinions were obtained. The thematic analysis of the experts' opinions was carried out, and the thought experiments were updated according to the identified themes. In addition, at this stage, the suitability of the experimental texts to the level of the students was calculated with the readability formula adapted from Flesch (1948) by Atesman (1997). The revised and updated thought experiments were sent to three linguistic experts and three domain experts. The experts were asked to rate the four thought experiments as 1 (Appropriate), 0 (Partially Appropriate), and -1 (Not Appropriate) in terms of scientific reasoning method characteristics by completing a linguistic opinion form and a content validity opinion form. Three linguistic experts rated all scientific reasoning methods for the four thought experiments with a mean of 1 (appropriate). Three domain experts rated the content validity form. Two domain experts rated all experiments as 1 (adequate) without suggesting any changes. The other expert suggested some superficial changes (such as the order of the experiments) and rated all experiments as 1 (appropriate). In the pilot study, 24 interviews were conducted with six students using four thought experiments. In addition to the leading researcher, an observer was present throughout the interviews. Based on the information obtained after the pilot application, two of the four thought experiments were selected for the actual application in terms of suitability for the study and student level. Before the actual implementation, minor updates were made to the experiments using the data obtained from the pilot study. The finalized experiments were sent to an assessment and evaluation expert, a language expert, and a field expert for expert review. According to the final expert review forms, three experts rated two thought experiments 1 (appropriate). Detailed information about the participants was obtained to prevent the loss of participants, and the participants and their families were fully informed about the process. Voluntary participation was required, and a voluntary participation form was obtained for each participant. In addition, it was ensured that the implementation site where the interviews would be conducted was in standard and appropriate conditions for all participants. An impartial observer was present with the researcher throughout the process. All interviews were audio recorded. For transferability, the research process, data, and setting were described in detail so that readers could make sense of the research findings and understand similar environments and processes.

The researcher re-evaluated and compared the data at two-week intervals to ensure consistency. She consulted experts and audio-recorded the interviews for consistency. The researcher first coded each participant's 17 responses to Thought Experiment 1 and Thought Experiment 2. Then she coded all participants for each question. In other words, both horizontal and vertical coding was done to avoid different coding of similar data. After this evaluation, the same evaluation was repeated two weeks later, and the similarities and differences between the codings were compared, and it was found that approximately 96% of the codings were similar.

For confirmability, two experts, an external measurement and evaluation expert and a field expert evaluated whether the judgments, interpretations, and suggestions made in the research were confirmed when looking at the raw data. According to the result obtained from the expert review form, they were asked to rate the consistency between the judgments, interpretations, and suggestions

reached and the raw data as 1 (appropriate), 0 (partially), and -1 (not appropriate). As a result, both experts rated the confirmation review with an average of 1 (appropriate).

2.6. Ethics Committee Approval Information

This study was reviewed by Hacettepe University Ethics Committee and an ethics committee approval certificate dated 03.02.2021 and numbered E-1431040 was issued. All rules specified in the "Higher Education Institutions Scientific Research and Publication Ethics Guidelines" have been followed throughout the entire process, from the planning and implementation of this research to the collection and analysis of data. None of the actions listed under the heading "Actions Contrary to Scientific Research and Publication Ethics" in the second section of the guidelines were carried out.

3. Findings

This section includes the findings related to the problem and sub-problems of the research under two sub-headings.

3.1. Characteristics of Participants' Scientific Reasoning in Social Sciences

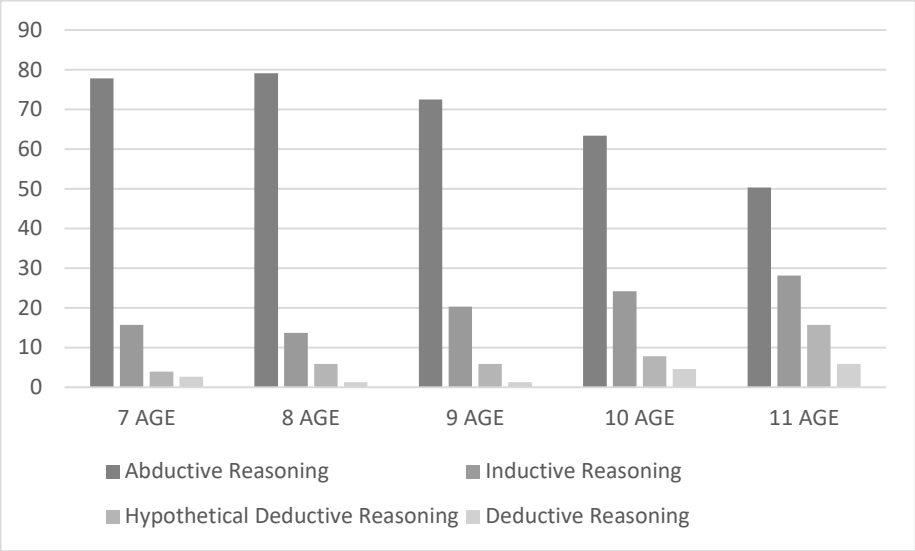
The results were obtained through two thought experiments. Eighteen interviews were conducted with nine participants from each age group. Each participant answered 17 questions based on the two thought experiments in the interviews, resulting in 153 responses. Table 4 shows the distribution of these responses by age and scientific thinking characteristics.

Table 4. *Characteristics of Scientific Reasoning in 7-11-Year-Old Children*

Age	Abductive	Inductive	Hypothetical Deductive	Deductive	Total
7	119	24	6	4	153
8	121	21	9	2	153
9	111	31	9	2	153
10	97	37	12	7	153
11	77	43	24	9	153

The characteristics of the four scientific reasoning methods were observed to varying degrees in all age groups. Regardless of age group, participants used abductive reasoning most often, followed by inductive and hypothetical deductive reasoning methods. Deductive reasoning was the least common scientific reasoning method in all age groups. The differences observed in the characteristics of scientific reasoning in each age group and the change with age are discussed in detail in Figure 3.

Figure 3. *Percentage Distribution of Scientific Reasoning Characteristics Observed in 7-11- Year-Old Children*

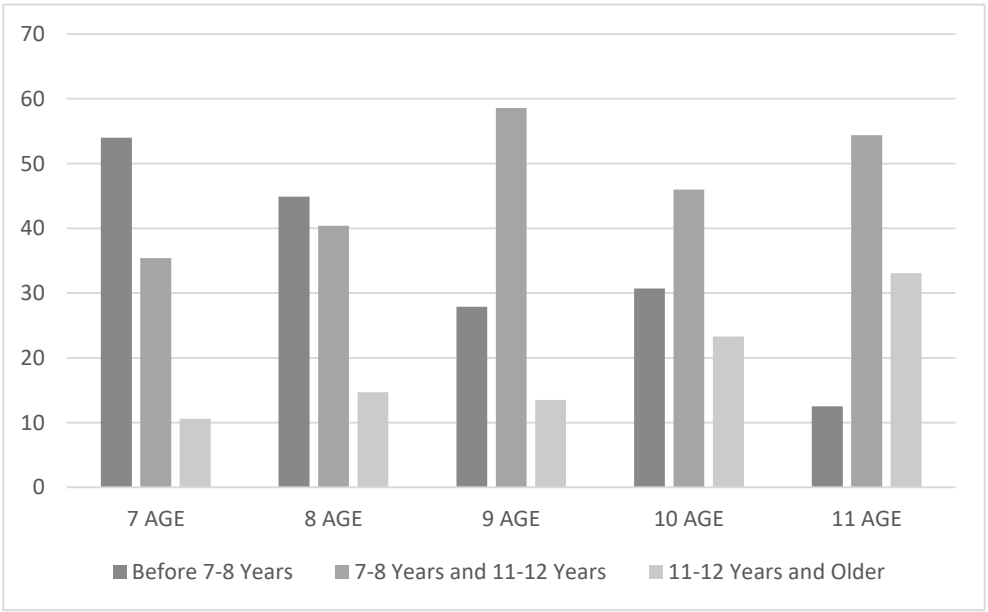


Abductive reasoning was the most common in all age groups. It was observed at a higher rate in the 7-8 age groups compared to other age groups. Beginning at age 9, this rate began to decrease and reached its lowest level with a rate of 50% in the age group of 11. Abductive reasoning decreased by about 25% from age 7 to age 11. In the 10-11 age group, the incidence of inductive, deductive, and hypothetical-deductive reasoning increased by 15% from age 10 to 11. Notably, however, the total prevalence of the characteristics of these three methods was 50% at age 11. Finally, the total rate of observation of deductive and hypothetical deductive reasoning methods, which are the defining features of the stage, was about 20% in the 11-year-old group.

3.2. Participants' Cognitive Developmental Stage Characteristics

Figure 4 shows which developmental stage characteristics the findings reflect according to Piaget's (1928) cognitive development theory.

Figure 4. *Cognitive Development Stage Characteristics of the Study Group*



The characteristics seen before ages 7-8 were at their highest level in age group 7. At age 9, this rate decreased relatively. Although it increased slightly at age 10, it decreased to about 12% at age 11. The characteristics seen between ages 7-8 and 11-12 increased from age 7 to age 9. It reached its highest level at age 9. At age 10, it began to decrease, while at age 11, it increased slightly to about 50%. The traits showed a relatively steady increase from ages 11-12 and beyond. It was about 10% at age seven, but at age 11, it was about 30%.

4. Discussion

This section includes discussions and comments on the main findings in the context of the relevant literature.

Main Finding 1: The four scientific reasoning methods were observed to varying degrees in all age groups. Participants, regardless of age group, used abductive reasoning the most, followed by inductive and hypothetical deductive reasoning. Deductive reasoning was also the least common scientific reasoning method across all age groups.

Cognitive development is defined as the process through which individuals develop increasingly complex and effective ways of understanding the world (Senemoğlu, 2018). Abductive reasoning, often considered the earliest form of reasoning used to make sense of the world, typically emerges first in children (Durhan, 2020). Therefore, it is not surprising that abductive reasoning was the most commonly observed method across all age groups. In contrast, deductive reasoning is based on drawing conclusions from general principles or a priori knowledge and requires a more advanced level of cognitive processing. As such, it is understandably less common in this age group. However, considering the wide age span encompassed by the concrete operational stage (7–11 years), it is important to examine the developmental differences between specific age groups in more detail to fully interpret these results.

Abductive reasoning is discussed in the context of the findings as a method through which individuals arrive at the most plausible or “best guess” conclusion (McGregor, 2014). However, this type of reasoning does not involve verification of the conclusion reached. Due to its creative and exploratory nature, abductive reasoning can be seen as a precursor to hypothetico-deductive reasoning, which incorporates both the generation of hypotheses and their empirical testing, key aspects of scientific inquiry. For this reason, it would be expected that as children progress between the ages of 7 and 11, the characteristics of abductive reasoning would gradually be replaced by those associated with reasoning types that emphasize verification, such as hypothetico-deductive and deductive reasoning. However, the findings show that abductive reasoning decreases by only about one-quarter during this developmental stage, which is not consistent with typical expectations based on cognitive development theory. From Piaget’s perspective (1928), when describing the reasoning characteristics of children aged 7–8 compared to those aged 11–12, he notes that while children in this range begin to seek reasons and evidence in addition to conclusions and explanations, they still rely heavily on their own beliefs and personal opinions, and tend to reason in relation to concrete situations. Prior to ages 7–8, children can predict what might happen in specific conditions or infer outcomes based on given scenarios, but their reasoning lacks the complexity of integrating evidence-based verification.

For this reason, it is possible to say that children who show characteristics of abductive reasoning based on prediction without evidence generally show characteristics before age 7-8.

However, while it is relatively understandable that the rate of observation of abductive reasoning traits is about 75% at ages 7 and 8 because of the presence of traits seen before ages 7-8, it is not understandable that 50% of abductive reasoning traits are still observed at age 11. Piaget (1928), while talking about the general characteristics seen at the age of 11-12 and later, stated that children in this stage show full inductive reasoning by accepting data as data, making generalizations, acting from the logic of relationships, drawing conclusions by using general propositions, and reasoning with the hypothetical deductive method with both finding and verifying aspects. However, if we examine the figure carefully, we can see that the total observation rate of the characteristics of the deductive and hypothetical deductive reasoning methods, which are the defining characteristics of the stage, is about 20% in the 11-year-old group. According to Piaget, it is possible to say that this rate is relatively low for our 11-year-old study group, which has entered the formal operational stage.

In the context of the Turkish education system, it can be said that the development of scientific reasoning in the social sciences at the basic education level is primarily targeted through the Life Sciences and Social Studies curricula, along with the accompanying textbooks. According to the specific objectives section of the Life Sciences curriculum for children aged 7–9, students are expected to acquire basic scientific process skills. The specific objectives section of the life science curriculum for children aged 7-9 states that children are expected to acquire basic scientific process skills. The specific objectives section of the social studies curriculum for 10-11-year-olds states that children are expected to observe scientific ethics in accessing, using, and producing information based on scientific reasoning. When we look at the situation in our 7-9-year-old study group, it was observed that the rate of abductive reasoning, in which skills such as observation, prediction, and estimation, which are among the basic scientific process skills, were very high for all three age groups and there was no significant change according to age. In this case, if the level of using basic cognitive process skills at the age of 7 is the same as that of the child at the age of 9, it is noteworthy at which stage the 7-year-old child may have acquired these skills and why these skills did not develop until the age of 9. Moreover, while the age of 9 corresponds to the middle of primary school education in many countries (USA, Japan, Spain, Belgium, etc.), it is considered the average age of transition to secondary school in Turkey (European Commission-EACEA, 2022). Accordingly, for our study group, it is possible to say that they continue to show the characteristics of the preoperational stage, that is, before the age of 7-8, until the age of transition to middle school. However, if we examine the objectives of the curricula of the Turkish education system, we see that for a student who completes primary school.

> *"To ensure that students who complete primary school become healthy, life-oriented individuals with self-confidence and self-discipline, who have acquired basic verbal, numerical and scientific reasoning, social skills and aesthetic sensitivity that they will need in everyday life, and who use them effectively within a framework of moral integrity and self-awareness by their developmental level and their own individuality [Ministry of National Education (MoNE), 2018]."*

This objective reflects the characteristics of the Concrete operational stage (See Table 2), one of the characteristics of the cognitive development stage.

> *"To ensure that students who complete secondary school become individuals who have adopted national and spiritual values, exercise their rights and fulfill their responsibilities, and have acquired the basic level skills and competencies expressed in the Turkish Qualifications Framework, as well as in discipline-specific areas by developing the competencies acquired in primary school (MoNE, 2018)."*

This goal reflects the characteristics of the formal operational stage (see Table 2). As a result, it can be said that the characteristics of the developmental stage in which the children are and the characteristics of the objectives set in the curricula do not coincide since our study group, between the ages of 7 and 11, follows the expected developmental stage one developmental stage behind according to Piaget's developmental theory. So what could be the reason for the children's cognitive delay? We do not believe there is a single answer to this question.

Many researchers argue that the social environment and culture in which children live affect their development (Shayer & Adey, 1981; Kind & Osborne, 2017; Losike-Sedimo, 2018; Bağcıoğlu Ünver, 2015; Dasen, 2018; Dzainudin et al., 2018; Greenfield, 2018; Senemoğlu, 2018; Aydın, 2020; İnanç et al., 2020). Students of the same age from many countries take international tests [PISA and Trends in International Mathematics and Science Study (TIMSS)] to determine their level of reasoning. Although they are of the same age, there are significant differences in their reasoning across countries. Just as it is not possible to say that the only reason for this difference is the culture in which the child lives, it is also not possible to say that cultural characteristics are not one of the reasons. Although there was a significant increase in the proportion of students representing our country in the 2018 PISA test who were at higher proficiency levels compared to 2015, the same report shows that 15-year-old Turkish students demonstrated reading skills at level 2 on average. Although some students individually show 3rd-level and even 6th-level behaviors, the overall average of the group remained at the 2nd level. The behaviors of the 15-year-old Turkish students participating in PISA 2018 at the third level, in which 15-year-old Turkish students are not included in terms of the overall average in reading skills, are expected to be as follows:

> *"Students at this level can express the general meaning of a text even when it is not explicitly stated. They can synthesize information and make simple and advanced inferences. They can synthesize information from different text parts to determine the main idea, understand relationships, and infer the meaning of a word or phrase. They can understand the relationships between information gathered according to different criteria. Students at this level can reflect on one or more texts. They can compare the points of view of different authors based on the information presented (MoNE, 2019)."*

The individual and overall average reading scores obtained in PISA support our findings. In this case, many general and specific factors, such as the cultural characteristics of our study group, the socio-cultural level of the family, the level of education, the inability to develop socialization awareness at the age of 7-8 due to the pandemic, the dominance of egocentric thinking characteristics due to reasons arising from the individual, family, society, etc., may be the reasons for cognitive lagging behind. In addition, we believe that the factor of education that children receive from the moment they are born, starting from the family and formal education when they reach school age, significantly affects their cognitive development and, accordingly, their scientific reasoning skills.

> *Main finding 2:* In our study group, it is seen that the incidence rate of inductive, deductive, and hypothetical deductive reasoning characteristics, which include characteristics such as accessing and using information based on scientific reasoning, increased by 15% from age 10 to age 11. However, it is noteworthy that the overall incidence rate at age 11 is still at 50%.

According to this finding, it is not an expected result that 50% of the children cannot act with logical thinking in gaining knowledge even in concrete situations and can only make guesses and predictions. We believe that these findings are significant in theory and practice.

Main finding 3: In our study group, it was observed that the characteristics seen before the age of 7-8 were at the highest level at the age of 7, and this rate decreased relatively until the age of 9. Although it increased slightly at age 10, it decreased to about 12% at age 11. The characteristics seen between the ages of 7-8 and 11-12 increased from 7 to 9 and reached the highest level at 9. At age 10, it began to decrease, while at age 11, it increased slightly to about 50%. When analyzing the characteristics at the ages of 11-12 and later, a relatively regular increase was observed at 7, around 10%, while at 11, around 30% was observed.

According to this finding, nine is critical for observing the characteristics between the ages of 7-8 and 11-12. In addition, in the data obtained from the study group, it is possible to say that the cognitive developmental characteristics of a child can belong to only one or two cognitive developmental stages. If he/she shows characteristics of two cognitive developmental stages, it is possible to say that this occurs with the sequential stage. For example, it is essential to note at this point that there is no finding, such as a child showing characteristics before the age of 7-8 showing characteristics after the age of 11-12 without showing characteristics between the ages of 7-8 and 11-12. This finding from the study supports Piaget's view that children cannot cognitively move from the preoperational stage to the formal operational stage without going through the Concrete operational stage (Wadsworth, 1975). However, the fact that the characteristics expected to be seen before age 7-8 (e.g., egocentric thinking, syncretism, integration, transductive thinking, imitation with imagination (Piaget, 1928)) were also seen in our study group at ages 10 and 11 was not consistent with Piaget's theory. It is not an expected finding that the characteristics expected to be observed at the ages of 11-12 and later were only observed at the age of 11 at a rate of 30%. Because abductive reasoning traits persist in the 11-year-old group and the expected increase in the observation of hypothetical deductive reasoning, fully inductive and deductive reasoning method traits do not materialize, supporting this situation. These findings also support Piaget's assumption that many adults cannot perform formal operational (Senemoğlu, 2018). In addition, while Piaget stated that the age of entering and completing the stage of cognitive development could vary from culture to culture and even within the same culture (Senemoğlu, 2018), Bruner, one of the important names in the field of cognitive development, explained cognitive development according to stages and argued that these stages occur in an unchanging order. However, unlike Piaget, he stated that the emergence of stages according to children's learning does not depend on age (Çeçen Eroğul, 2021). The results of our study group support these statements. For example, there are children in the 11-year-old group who are 7-8 years old, i.e., preoperational stage characteristics, as well as children in the 7-year-old group who are 11-12 years old, and later, i.e., formal operational stage characteristics, although at a low rate, and even children who show three different cognitive stage characteristics, namely, preoperational stage, Concrete operational stage, and formal operational stage, are in the same age group. In addition, when reviewing the relevant literature, there are studies (Shayer & Adey, 1981; Commons, 2008; Losike-Sedimo, 2018; Greenfield, 2018; Dzainudin et al., 2018) that support the findings of the study.

5. Conclusion and Recommendations

This study aimed to examine the characteristics of scientific reasoning in social sciences and the cognitive developmental stages of children aged 7 to 11. To this end, the study focused on the scientific reasoning abilities and cognitive developmental characteristics of children within the concrete operational stage, according to Piaget’s theory of cognitive development. The study group consisted of students aged 7–11, encompassing this developmental period.

Based on the findings, the following conclusions were drawn:

In each age group between 7 and 11 years, all four scientific reasoning methods were observed in varying frequencies and proportions. Abductive reasoning was observed at high and medium levels among 7- to 9-year-olds, whereas in 10- and 11-year-olds, it was observed at high, medium, and low levels. Additionally, inductive reasoning was observed at medium and low levels across all age groups, while both hypothetico-deductive and deductive reasoning were consistently observed at low levels in all groups. Based on these findings, it can be inferred that the scientific reasoning characteristics of children who begin elementary school at age 7 remain relatively stable until age 9. Based on the fact that they showed preoperational stage characteristics until the age of 7, it can be said that they continued to show preoperational stage characteristics until the age of 9. It would not be correct to expect that students who start showing concrete operational stage characteristics at nine would switch to the formal operational stage at 11. This is supported by the fact that from the age of 7 to the age of 11, they could not show the inductive reasoning characteristics, which are the characteristics of the Concrete operational stage, at a high level, and the formal operational stage characteristics, in which reasoning characteristics such as hypothetical deductive and deductive reasoning are expected from them at the age of 11, even at a moderate level. However, despite the assumption that the ages of entering and exiting the developmental stages in Piaget's theory of cognitive development may vary from culture to culture and even within the same culture when we look at the general situation of our small study group, the fact that the preoperational stage characteristics continued at a high level until age nine and the Concrete operational stage characteristics were not seen at a high level suggests that the Concrete operational stage began around age 9. However, when we look at the data obtained from the 11-year-old group, it is seen that we cannot comment on the age of the transition to the formal operational stage because 11-year-old children, our last age group, still show medium and low levels of Concrete operational stage characteristics. The results are pretty different when the children in the study group are analyzed individually. In each age group, some children showed characteristics of both preoperational, concrete operational, and formal operational stages. This means children of the same age with different cognitive developmental stage characteristics can be in the same classes. At the age of 11, children who intensively show the characteristics of the preoperational and concrete operational stages are educated at a higher education level whose teaching is structured by accepting that they are in the formal operational stage.

Similarly, at the age of 7, children who intensively show the characteristics of the Concrete operational and formal operational stages are educated in classes whose teaching is structured by assuming they are only in the Concrete operational stage. As a result, for the study group of this research, it is seen that the group's age is quite behind in terms of the expected characteristics, and the group cannot show scientific thinking characteristics at the expected level. In this case, the roles of educational stakeholders such as educational policymakers, curriculum developers, textbook writers, academicians, and teachers in structuring the educational system come into play:

We believe that there will always be students who are left behind in the system if

- Educational policymakers, who study and research the developments, changes, and needs in education and structure the educational system accordingly, are often unable to carry out the necessary study, research, and development activities.
- Curriculum developers prepare curricula based on assumptions about the developmental characteristics of students without relying on factual data. Accordingly, textbook authors write textbooks assuming that they consider students'

developmental characteristics because they cannot go beyond the program outcomes when writing their books.

- Academics do not train teachers who consider children's developmental characteristics and know how to develop them.
- Teachers do not include learning-teaching activities, such as providing children with scientific reasoning skills to accelerate their cognitive development.

In light of the results and the possible explanations for these findings, we propose the following recommendations for practice and future research:

- Researchers should investigate why the ages at which children in our study group enter and complete cognitive developmental stages lag significantly behind the age ranges proposed by Piaget's theory.

- This study, conducted with a small sample, should be replicated on a national scale to provide a comprehensive overview of children in the Turkish education system. Such research would clarify the typical ages at which children enter and exit cognitive developmental stages and the scientific reasoning characteristics they exhibit, and help inform the structuring of the education system, particularly regarding school entry ages and grade progression policies.

- Researchers should design theoretical and experimental studies to explore how children with similar developmental characteristics but differing chronological ages can be educated together in classrooms, using curricula and textbooks tailored to their developmental needs.

- Thought experiments should be employed as a valid and reliable assessment tool within social sciences research. Future studies should include diverse participant groups to compare findings with those of this study.

- Guidance and counseling professionals are encouraged to use the data collection toolkit developed in this study to better understand students' scientific reasoning abilities and cognitive developmental stages.

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Appendices

Appendix 1. Thought Experiment-1: World Class (Without Visuals)

WORLD CLASS	Children from 6 countries came together for the World Class Project. A total of 25 children between the ages of 5-15 from Turkey, Germany, China, England, Russia and Egypt came to Ankara. The project would last for 3 months and the children in the project would gather in a classroom every day and do various activities. The teacher in charge of the project decided to choose a class representative from these children to represent their class for 3 months. But how?
I'm Leon. I was born in Germany. I'm 13 years old. I have a sister. I went to school every day. I have never been absent. I have been playing volleyball for 2 years. I have read hundreds of books since I learned to read. No one has ever asked me to do good deeds. It was my mother's idea to participate in this project. It is very nice to be here. I want to run for class representative.	I'm Yun. I was born in China. I have two siblings. I've been playing the violin since Grade 1. Many times I've warned my friends who were unfair in games. I've told them what the right thing to do should be and made them do the right thing. I've been named a good student twice. I've only read 50 books from Grade 3 until now, although I read a total of 40 books in Grade 1 and 2. I'm here because I want to be a class representative candidate.
I'm Mano. I was born in Egypt. I'm 10 years old. I am a goalkeeper in our neighborhood soccer team. One day I got injured in a game and missed 10 days of school. I read a lot of books while I was resting at home. I must have read more than a hundred books so far. The teacher in the Art Club selected my paintings for an exhibition this year and gave me the title of "good student". My teacher asked me to participate in this project. I want to be a candidate for class representative.	I am Ayse. I was born in Turkey. I have no siblings. I have never missed a class at school. If there is a problem in class, everyone comes to me. They ask me to find a solution. I have solved many problems so far. I have never received a letter from any of them. If I had, my favor letters would have exceeded 10. I do karate. I like reading books, but I couldn't finish many books because I have reading difficulties. I am taking a ceramics course this year because my mother wants me to. I want to be a candidate for class representative.

Requirements to be a Class Representative Candidate:

1. Having read a total of 100 books so far
2. Receiving the title of "Good Student"
3. Be between the ages of 7-14
4. Being absent for less than 10 days at home school
5. Engaging in a sport
6. Dealing with a branch of art
7. Having letters from at least 10 people about his/her good deeds
8. To have produced a solution to any problem experienced in class

Thought Experiment-1 World Class: **Interview Questions**

Free Time

1. What do you think the characteristics of a class representative should be?
2. If you were the teacher in charge of the World Class Project, how would you go about selecting a class representative?

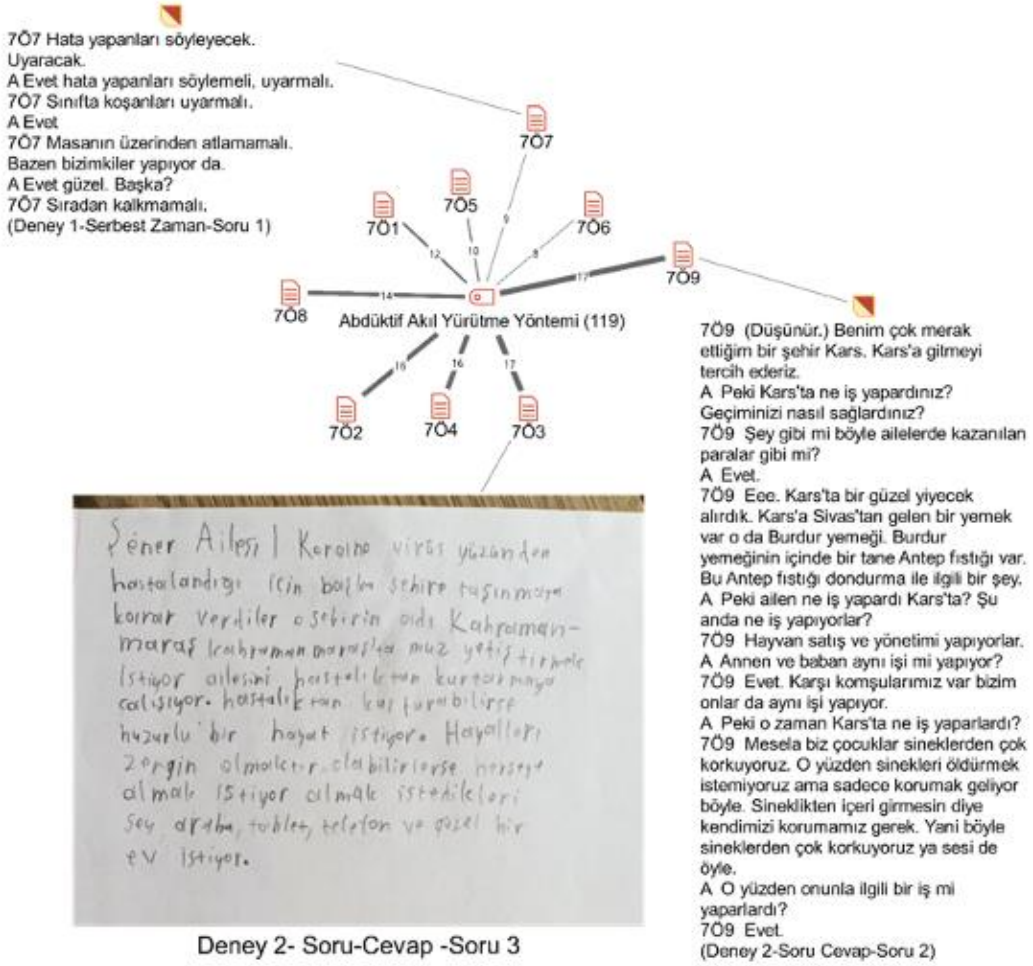
Enrichment

3. Do you think Leon can run for class representative? Why is that?
4. Do you think Mano can run for class representative? Why is that?
5. Do you think Ayse can run for class representative? Why is that?
6. Do you think Yun can run for class representative? Why is that?

Q&A

7. According to these conditions, who/who do you think can be a candidate for class representative? Why?
8. How would you go about selecting the class representative if there were more than one qualified candidate? Why?
9. Which of these students or students would you like to see become the head of state in the future? Why?
10. I would like you to think of a student who is involved in this project and wants to be a class representative candidate. Can you write a text in which this student introduces himself/herself like the students here?

Appendix 2. Sample Findings (Age 7- Abductive Reasoning)



When the figure is analyzed, it is possible to say that each of the 9 students in the 7-year-old study group had abductive reasoning method features at varying rates. When the sample excerpts obtained from the interview records given in the figure are examined, the student coded 7Ö7 explained the first question of the first stage of Experiment 1 (What do you think the characteristics of a class representative should be?) based on his own observations and experiences, based on his incomplete associations and made a possible inference. For example, it was observed that the expressions used by the student as "He/she will tell and warn those who make mistakes, warn those who run in the classroom, not jump over the table and not get up from his/her desk" actually cover the rules that should be followed in the classroom even though not every student is a class representative and that he/she could not make an association with the concept of "representation". In Experiment 2, the student with the code 7Ö3 started from his own observations and experiences in the sample case text he wrote for the last question of the 3rd stage, "I want you to think of a family that has been negatively affected by this pandemic and has decided to migrate from the city where they live to another city. Can you write a text describing the decision process of this family in your imagination like the families here?". He included expressions based on his missing associations and made possible inferences. For example, he started from their dreams of becoming rich, buying the things they wanted such as cars, phones, tablets and living a peaceful life. They might have thought that they would make a living by growing bananas in Kahramanmaraş.

Geniş Özet

Giriş

Gelişim psikologları bilişsel gelişimi etkileyen birçok faktör olduğunu söylemektedir. Bu faktörler incelendiğinde kalıtımsal özellikler ve biyolojik olgunlaşma etkenlerinin yanı sıra çocukların içinde bulundukları sosyal çevrenin ve kültürün etkisi ön plana çıkmaktadır (Shayer & Adey, 1981; Kind & Osborne; 2017; Losike-Sedimo, 2018; Bağcıoğlu Ünver, 2015; Dasen, 2018; Dzainudin et al., 2018; Greenfield, 2018; Senemoğlu, 2018; Aydın, 2020; İnanç ve diğerleri, 2020). Jean Piaget, bilişsel gelişim kuramında, gelişim dönemlerinin her kültürde aynı sırayı takip ederek ilerlediğini ancak gelişim dönemlerine girme ve tamamlama yaşlarının kültürden kültüre hatta aynı kültürde farklılık gösterebileceğini vurgulamıştır (Inhelder & Piaget, 1958). İspanya, Belçika, Litvanya, Lüksemburg, Hollanda, İsviçre gibi birçok Avrupa ülkesinde (European Commission-EACEA, 2022), Japonya'da (National Information Center Japan- NICJP, 2023) ve Amerika'da (U.S. Department of Education, 2023) ilkokul dönemi ortalama yaş aralığının 6-12 yaş olması tesadüf değildir. Bu yaş aralığındaki çocukların Piaget'ye göre işlem öncesi dönemin sonunda, somut işlemler döneminde (7-11 yaş) olduğunu ve soyut işlemler dönemine geçişin başladığını (Piaget & Inhelder, 1969) söylemek mümkündür. Türkiye'de ise ilkokul dönemi ortalama yaş aralığının 5,5 ve 9,5 yaş olduğu görülmektedir (European Commission-EACEA, 2022). Bu yaş aralığındaki çocukların ise işlem öncesi dönemin ortasından başlayıp somut işlemler döneminin ortasına kadar ilerleyebileceği varsayılmaktadır (Piaget & Inhelder, 1969). Ülkeler arasındaki benzerlik ve farklılıklar göz önüne alındığında yaş aralığı fark etmeksizin her durumda çocukların içinde bulundukları gelişim dönemleri bilinmeden genel bir varsayımla eğitim kademelerinin belirlenmesinin, eğitim materyallerinin hazırlanmasının ve hatta öğretmen eğitimlerinin bu yönde verilmesinin eğitim sisteminin kalitesi ve çıktıları bakımından uygun olmayacağı düşünülmektedir.

Piaget, çocukların akıl yürütme özelliklerini inceleyerek içinde bulundukları gelişim dönemlerinin özelliklerini belirlemiştir (Piaget, 1928). Piaget'nin bilişsel gelişim dönemlerine göre belirlediği bilimsel akıl yürütme özellikleri referans alınarak yürütülecek bir çalışmanın farklı kültürlerdeki çocuklar için yukarıda belirtilen durumun geçerliğinin ortaya konmasında alana önemli katkılar sağlayacağı düşünülmüştür. Bu nedenle bu çalışmada küçük bir çalışma grubu ile ilgili konu hakkında Türkiye'deki durum incelenmiştir. İlgili alanyazında bilimsel akıl yürütmenin incelenmesinde ve değerlendirilmesinde klinik görüşme yöntemi (Inhelder & Piaget, 1958) ya da klasik kâğıt kalem testleri (Lawson, 1978; Tobin & Capie, 1981; Roadrangka et al., 1982; Drummond & Fischhoff, 2017) kullanıldığı görülmektedir. Bilimsel akıl yürütmenin değerlendirilmesinde senaryoların kullanıldığı farklı bir yöntem ise düşünme deneyleridir (Lattery, 2001). Türkiye'de ve dünyada konu ile ilgili yürütülen çalışmalar incelendiğinde hem bilimsel akıl yürütmeyi hem de düşünme deneyleriyle bilimsel akıl yürütmenin incelenmesini ve değerlendirilmesini ele alan çalışmaların (Lawson, 1978; Tobin & Capie, 1981; Roadrangka et al., 1982; Zimmerman, 2000; Acar, 2013; Wilhelm et al., 2018; Stammen et al., 2018; Ateş 2019; Tüysüz ve Tüzün, 2020, Tüzün 2020) genellikle "fen bilimleri" alanında olduğu görülmektedir. Ancak her bir birey için sosyal bilimlerin günlük hayattaki varlığının en az fen bilimleri kadar önemli (Ernst Mach (1905/1976); Georgiou, 2005) olduğunu biliyoruz. Bu nedenle bilimsel akıl yürütme özelliklerinin incelenmesinde sosyal bilimler alanında yapılacak çalışmaların da alanyazına önemli katkılar sağlayacağını düşünerek bu çalışmada bilimsel akıl yürütme özellikleri sosyal bilimlerde hazırlanmış düşünme deneyleri kullanılarak incelenmiştir. Bu çalışmanın Türkiye'de ve dünyada daha büyük çalışma grupları ile benzer çalışma yürütmek isteyen tüm araştırmacılara referans olacağını düşünüyoruz. Bu araştırmamızın problem cümlesi şu şekildedir:

7-11 yaşlarındaki çocukların sosyal bilimlerde gösterdikleri bilimsel akıl yürütme ve bilişsel gelişim dönemi özellikleri nelerdir?

1. 7-11 yaşlarındaki çocukların sosyal bilimlerde gösterdikleri bilimsel akıl yürütme özellikleri nelerdir?

2. 7-11 yaşlarındaki çocukların gösterdikleri bilişsel gelişim dönemi özellikleri nelerdir?

Yöntem

Bu çalışmada araştırmanın deseni, bütüncül çoklu durum deseni olarak belirlenmiştir. Araştırmanın amacı doğrultusunda çalışma grubunu oluşturabilmek için tercih edilen örnekleme yöntemi amaçlı örnekleme yöntemidir. 7-11 yaşları arasında olan öğrencilerin belirlenebilmesi için amaçlı örnekleme deseni tercih edilmiştir. Araştırmanın amacı doğrultusunda bazı ölçütler belirlenmiştir. Bu ölçütler yaş, sosyo-kültürel düzey, bilişsel gelişim dönemi ve maksimum çeşitlilik sağlamadır. Araştırmanın çalışma grubunu her yaş grubundan ve üç sosyo-kültürel düzeyde somut işlemler döneminde olan üç öğrenci olmak üzere toplam 45 öğrenci oluşturmaktadır.

Araştırmanın veri toplama sürecinde nitel araştırma veri toplama yöntemlerinden görüşme ve gözlem yöntemleri kullanılmıştır. Bu araştırmada bu çalışma için hazırlanan düşünme deneylerine öğrencilerin verdikleri yanıtlar derinlemesine incelendiğinden yarı yapılanmış görüşme (Fraenkel et al., 2012) tercih edilmiştir. Araştırmada yürütülen görüşmeler ses kaydına alınmıştır. Ses kaydına alınan görüşmeler araştırmacı tarafından yazılı rapor hâline getirilmiştir. Görüşmeler ve ses kaydı için hem çocuklardan hem de çocukların ailelerinden bu çalışmaya gönüllü katılım sağladıklarına dair "gönüllü katılım formu" alınmıştır.

Kırk beş öğrenci ile iki düşünme deneyi için toplam 90 görüşme yapılmıştır. Görüşmelerde bu çalışma için hazırlanan iki düşünme deneyi kullanılarak veri toplanmıştır. Çalışma grubu ile yarı yapılandırılmış görüşmeler gerçekleştirilmiş ve görüşmeler esnasında araştırmacı tarafından düşünme deneyleri ile ilgili bazı sorular içeren yarı yapılanmış görüşme formu kullanılmıştır. Yarı yapılanmış görüşmelerde çalışma grubuna ilişkin araştırmacı tarafından gözlem notları alınmıştır. Ayrıca araştırmacı tarafından bilimsel akıl yürütme özellikleri ve görüşme sorularından oluşan "Bilimsel Akıl Yürütme Özellikleri Gözlem Formu (Kontrol Listesi)" hazırlanmıştır. Gözlem formundan elde edilen gözlem notları da veri toplama aracı olarak kullanılmıştır.

Araştırmadan elde edilen veriler nitel araştırma veri analizi yöntemlerine uygun olarak analiz edilmiştir. Ayrıca veri analizinde nitel verilerin analizinde kullanılan MAXQDA 2020 programı kullanılmış ve ilgili görsel araçlar bu programda oluşturulmuştur. Bu araştırmanın çalışma grubundan elde edilen veriler betimsel analiz yöntemi kullanılarak analiz edilmiştir.

Bu çalışmanın nitel verilerinin iç geçerliğini sağlamada inandırıcılık için uzun süreli etkileşim, derin odaklı veri toplama çalışması, veri toplama yöntemi çeşitlemesinin yanı sıra uzman incelemesine başvurulmuştur. Uzman görüşleri neticesinde yeniden hazırlanan ve güncellenen düşünme deneyleri 3 dil uzmanı ve 3 alan uzmanına gönderilmiştir. Dil uzmanı görüş formu ve alan uzmanı kapsam geçerliliği görüş formu hazırlanarak uzmanlardan 4 düşünme deneyini bilimsel akıl yürütme yöntemi özellikleri bakımından 1 (Uygun), 0 (Kısmen), -1 (Uygun Değil) şeklinde değerlendirmeleri istenmiştir. 3 dil uzmanı 4 düşünme deneyi için tüm bilimsel akıl yürütme yöntemlerini 1 (Uygun) ortalama ile değerlendirmiştir. Kapsam geçerliliği formunu 3 alan uzmanı değerlendirmiştir. İki alan uzmanı herhangi bir değişiklik önermeden tüm deneyleri 1 (uygun) olarak değerlendirmiştir. Diğer uzman ise deneylerde bazı yüzeysel değişiklik (sıralama gibi) önermiş ve o da tüm deneyleri 1 (uygun) olarak değerlendirmiştir. Ardından pilot uygulamaya geçilmiştir. Pilot uygulamada toplam 6 öğrenci ile 4 düşünme deneyi kullanılarak 24 görüşme gerçekleştirilmiştir. Görüşmeler boyunca asıl araştırmacının yanı sıra bir

gözlemci yer almıştır. Pilot uygulama sonrası elde edilen bilgiler ışığında çalışmanın amacına ve öğrenci seviyesine uygunluk bakımından 4 düşünme deneyinden 2 düşünme deneyi asıl uygulama için seçilmiştir. Asıl uygulamaya geçilmeden önce pilot uygulamadan elde edilen veriler ile deneylerde küçük güncellemeler yapılmıştır. Son şekli verilen deneyler 1 ölçme değerlendirme, 1 dil ve 1 alan uzmanına yeniden uzman incelemesi için gönderilmiştir. Son uzman incelemesi formlarına göre belirlenen iki düşünme deneyi üç uzmandan tarafından 1 (uygun) olarak değerlendirilmiştir. Aktarılabilirliğin sağlanmasında, çalışmayı okuyan bireyler için araştırma sonuçlarının anlam kazanması ve okuyucuların benzer ortamlara ve süreçlere ilişkin anlayış oluşturmaları için araştırma süreci, elde edilen veriler ve ortam ayrıntılı olarak betimlenmiştir. Tutarlığın sağlanması için bu çalışmada elde edilen veriler araştırmacı tarafından iki hafta arayla yeniden değerlendirilmesi ve karşılaştırılması, uzman incelemesine başvurulması ve görüşmelerin ses kaydına alınması ile tutarlık incelemesi yapılmıştır. Araştırmacı tarafından öğrencilerin düşünme deneyi 1 ve düşünme deneyi 2'ye verdiği toplam 17 cevap öncelikle her öğrenci için kendi içinde kodlanmıştır. Ardından 17 soruya verilen cevaplar her bir soru için tüm öğrenciler kodlanarak elde edilmiştir. Bu değerlendirmenin ardından iki hafta sonra aynı değerlendirme bir kez daha tekrarlanmış ve kodlamalar arasındaki benzerlik ve farklılıklar karşılaştırılmış ve yaklaşık %96 oranında benzer kodlama yapıldığı belirlenmiştir. Teyit edilebilirliğin sağlanması için bu çalışmada dışarıdan bir ölçme değerlendirme ve bir alan uzmanı olmak üzere iki uzman tarafından araştırmada ulaşılan yargıların, yorumların ve önerilerin ham verilere bakıldığında teyit edilip edilmediğine ilişkin değerlendirmeler yapılmıştır. Uzman incelemesi formundan elde edilen sonuca göre ulaşılan yargılar, yorumlar ve öneriler ile ham verilerin arasındaki tutarlığı 1 (Uygun), 0 (Kısmen), -1 (Uygun Değil) şeklinde değerlendirmeleri istenmiştir. Sonuç olarak iki uzman da teyit incelemesini 1 (Uygun) ortalama ile değerlendirmiştir.

Bulgular

Bu çalışmada dört bilimsel akıl yürütme yöntemi özelliklerinin tüm yaş gruplarında değişen miktarda gözlemlendiği görülmüştür. Verilen cevaplarda yaş grubu fark etmeksizin en çok abdüktif akıl yürütme yöntemi özellikleri görülürken bu yöntemi sırasıyla tümevarım ve hipotetik tümdengelim akıl yürütme yöntemi takip etmiştir. Tümdengelim akıl yürütme yöntemi özellikleri de tüm yaş gruplarında en az görülen bilimsel akıl yürütme yöntemi olmuştur. Tüm yaş gruplarında en çok görülen abdüktif akıl yürütme özelliklerinin 7- 8 yaş gruplarında diğer yaşlara göre daha yüksek oranda gözlemlendiği; 9 yaştan itibaren bu oranda azalmanın başladığı ve 11 yaş grubunda ise %50 oranı ile en düşük seviyeye ulaştığı görülmektedir. Abdüktif akıl yürütme özelliklerinin gözlenme durumunun 7 yaştan 11 yaşa kadar yaklaşık olarak %25 oranında azaldığı söylenebilir. Çalışma grubunda 10-11 yaş çocuklarında tümevarım, tümdengelim ve hipotetik tümdengelim akıl yürütme özelliklerinin görülme oranının 10 yaştan 11 yaşa %15 seviyesinde bir artış gösterdiği görülmektedir. Ancak 11 yaşta bu üç yöntemin özelliklerinin toplam görülme oranının %50 seviyesinde olması dikkat çekici bir bulgudur. Son olarak 11 yaş grubunda dönemin belirleyici özelliklerinden tümdengelim ve hipotetik tümdengelim akıl yürütme yöntemi özelliklerinin toplam gözlemlenme oranının %20 civarında olduğu görülmektedir.

Piaget'e göre (1928), 7-8 yaş öncesi görülen akıl yürütme özelliklerinin; çalışma grubunda 7 yaş çocuklarında en yüksek seviyede olduğu, 9 yaşa kadar bu oranın görece azaldığı görülmektedir. 10 yaşta bir miktar artış gösterse de 11 yaşta yaklaşık %12 seviyesine inmiştir. 7-8 yaş ve 11-12 yaş arası görülen özellikler ise 7 yaştan 9 yaşa kadar artış göstermiş 9 yaşta en yüksek seviyeye ulaşmıştır. 10 yaşta azalma başlarken 11 yaşta bir miktar artışla %50 civarında görülmüştür. 11-12 yaş ve sonrası özellikler incelendiğinde nispeten düzenli bir artış sergilediği 7 yaşta %10 civarında görülmesine karşın 11 yaşında %30 civarında görülmüştür.

Sonuç ve Öneriler

7-11 yaş aralığındaki her yaş grubunda dört bilimsel akıl yürütme yöntemi özellikleri de değişen kişi ve oranlarda görülmüştür. Abdüktif akıl yürütme özellikleri 7 yaştan 9 yaşa kadar yüksek ve orta düzeylerde görülürken 10 yaş ve 11 yaş çocuklarında yüksek, orta ve düşük düzeyde görüldüğü sonucuna ulaşılmıştır. Ayrıca tümevarım akıl yürütme özellikleri 7 yaştan 11 yaşa kadar olan tüm yaş gruplarında orta ve düşük düzeyde görülürken hipotetik tümdengelim ve tümdengelim akıl yürütme özelliklerini tüm yaş gruplarında düşük düzeyde görüldüğü sonucuna ulaşılmıştır. Elde edilen bu sonuçlar ışığında 7 yaşında ilkokula başlayan bir öğrencinin gösterdiği bilimsel akıl yürütme özelliklerinin 9 yaşına kadar değişmediğini söylemek mümkündür. 7 yaşına kadar işlem öncesi dönem özellikleri gösterdiklerinden hareketle aslında 9 yaşına kadar işlem öncesi dönemin özelliklerini göstermeye devam ettikleri söylenebilir. 9 yaşında somut işlemler dönemi özelliği göstermeye başlayan öğrencilerin 11 yaşında soyut işlemler dönemine geçmeleri beklemek doğru olmayacaktır. Bu durumu somut işlemler dönemi özellikleri olan tümevarım akıl yürütme özelliklerini 7 yaşından 11 yaşına kadar yüksek düzeyde, 11 yaşında kendilerinden beklenen hipotetik tümdengelim, tümdengelim gibi akıl yürütme özelliklerinin görüldüğü soyut işlemler dönemi özelliklerini ise orta düzeyde dahi gösterememeleri de desteklemektedir. Bununla birlikte Piaget'nin bilişsel gelişim kuramında yer alan gelişim dönemlerine girme ve tamamlama yaşlarının kültürden kültüre hatta aynı kültür içinde değişebileceği varsayımına karşın küçük çalışma grubumuzun genel durumuna bakıldığında işlem öncesi dönem özelliklerinin 9 yaşına kadar yüksek düzeyde devam etmesi somut işlemler dönemi özelliklerinin yüksek düzeyde görülmemesi somut işlemler döneminin 9 yaş civarında başladığını düşündürmektedir. Ancak 11 yaş grubundan elde ettiğimiz verilere bakıldığında soyut işlemler dönemine geçişinin yaşı ile ilgili yorum yapamadığımızı çünkü son yaş grubumuz olan 11 yaşındaki çocukların halen orta ve düşük düzeyde somut işlemler dönemi özelliklerini gösterdikleri görülmektedir. Çalışma grubunda çocuklar bireysel olarak incelendiğinde ise çok daha farklı bir sonuç ile karşılaşılmaktadır. Her yaş grubunda hem işlem öncesi dönem hem somut işlemler hem de soyut işlemler dönemi özellikleri gösteren çocukların olduğu görülmektedir. Bu demektir ki aynı yaşta olup farklı bilişsel gelişim dönemi özellikleri taşıyan çocuklar aynı sınıflarda olabilmektedir. 11 yaşında işlem öncesi ve somut işlemler dönemi özelliklerini yoğun olarak gösteren çocuklar soyut işlemler döneminde olduğu kabul edilerek öğretimi yapılandırılan bir üst eğitim kademesinde öğrenim görmektedirler. Aynı şekilde 7 yaşında somut işlemler ve soyut işlemler dönemi özelliklerini yoğun olarak gösteren çocuklar yalnızca somut işlemler döneminde olduğu kabul edilerek öğretimi yapılandırılan sınıflarda öğrenim görmektedirler. Sonuç olarak bu araştırmanın çalışma grubu için çoğunlukla yaşının beklenen özellikleri bakımından oldukça geride kaldığı ve grubun bilimsel akıl yürütme özelliklerini beklenen düzeyde gösteremediği görülmektedir. Bu durumun nedenlerinin araştırılması, küçük bir grupla yürütülen bu çalışmanın ülke genelinde yürütülerek bu anlamda Türk eğitim sistemindeki çocukların bilişsel gelişim dönemlerine girme ve tamamlama yaşları, gösterdikleri bilimsel akıl yürütme özellikleri gibi genel bir tablo çıkarılmasının ve okula başlama yaşları ve kademe geçişleri başta olmak üzere eğitim sisteminin buna göre yapılandırılması gibi konularda yapılacak çalışmaların eğitim bilimi ve ilgili alan yazının desteklenmesi bakımından önemli olduğu düşünülmektedir.

Declaration of Publication Ethics

This study was reviewed by Hacettepe University Ethics Committee and an ethics committee approval certificate dated 03.02.2021 and numbered E-1431040 was issued. We hereby declare that the study does not have unethical issues and that research and publication ethics have been observed carefully.

Declaration of Contribution of Researchers

The subject of the study was determined by all authors. Data collection tools were determined by author1. The data collection process was carried out by author2. Analysis of the data was done by author1. The literature review was conducted by author1. The writing process was carried out with the joint contribution of all authors. Control and supervision of the process was done by author2. All authors discussed the results and contributed to the final manuscript. The author1 contributed 50% and the author2 contributed 50%.

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