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Investigation of Gifted Students' Cognitive Structures on the concept of Innovation

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ABSTRACT
The aim of this research is to analyze the cognitive structures of gifted students regarding the concept of innovation. The phenomenology design, one of the qualitative research method designs, was used in the study. The criterion sampling method, one of the purposeful sampling methods, was used to determine the study group of the research. In the 2018 - 2019 academic year, 25 (15 male, 10 female) gifted students at the 7th and 8th grade level of secondary school in a Science and Art Center (BİLSEM) in Ankara Province formed the study group of the research. The word association test (WAT) and drawings were used as data collection tools in the research. While the data obtained with the drawing-writing technique in the research were analyzed by using the content analysis method, the data obtained through the word association test were analyzed by using the descriptive analysis method. Participants' associations to the concept of innovation were analyzed by using the cut-point technique. In addition, concept networks that show the associations at each breakpoint as a whole were drawn. Mind maps were drawn by using the frequency table prepared from the students' responses to the selected key concepts. Research data were collected under 7 categories. These were Definition and characteristics of innovation (f = 78), innovation and development (f = 52), stages of innovation (f = 46), innovation and business (f = 27), innovation-oriented skills (f = 18), innovation and product (f = 17), other (non-category concepts) (f = 13). It was determined that students produced 38 different answer words about the concept of innovation 251 times and they most associated the concept of innovation with the concepts of "newness", "development" and "technology". In the sentences they wrote together with the drawings, explanations emphasizing more technological products and development processes were observed.

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Drawing - writing technique, gifted student, innovation, phenomenology, science and art center, word association test.

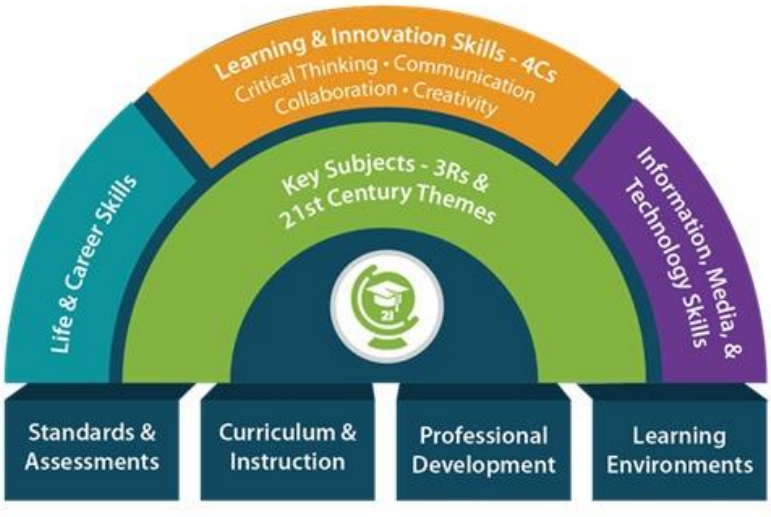
Introduction

Please The rapid developments in the field of science and technology in our age have affected human beings in every field. The information and behaviors that individuals should have, change as well in parallel with the advancement in technology (Ormanci, 2020). These rapid developments have also changed the desired and required characteristics of a qualified person. The characteristics of a qualified individual for the business world differ from those of a decade ago. Today, 65% of the children who start primary school will start working in completely new types of jobs that do not exist yet (World Economic Forum, 2016). Partnership for 21st Century Skills (P21) aims to prepare each student for the changing and digitalizing 21st century and was established for this purpose, defines 21st century skills as a mixture of skills such as content, special skills, expertise, and necessary literacy

students need to succeed in work and life. P21 classifies 21st century skills as learning and innovation skills, life and career skills, information media, and technology skills (Figure 1).

Figure 1

21st Century Learning Framework



Note. (Battelle for Kids, 2019)

Many developed countries have taken important steps towards raising human resources who are equipped with 21st century life skills and competencies which are required for innovation. Today, it has been understood that the innovation realized by all states and companies with the aim of increasing competition and continuing the development processes is an important skill that should be acquired by students in educational environments as a necessary individual feature in the globalized world.

The concept of innovation, which has started to be mentioned frequently with science and technology, is defined as "new or significantly changed product (good or service) or process; a new marketing method; or the application of a new organizational method in business practices, workplace organization or external relations" in in the Oslo Guide (OECD / Eurostat, 2018). The concept of innovation in the science textbooks of the Ministry of National Education (Turkey) [MoNE] is defined as "developing, changing and renewing an existing product to be more efficient" (Seyrek et al., 2019; p.13).

In parallel with these developments in the globalizing world, the concept of innovation gains importance in Turkey. Since 2014, with the protocol signed between the Ministry of National Education, Turkey Exporters Association, and Dream Partners Association innovation workshops have been established in schools (MoNE, 2014). Especially the Ministry of Education, The Ministry of Science, Industry, and Technology, municipalities, NGOs, and high-level production-based corporations organize workshops, supportive training courses for innovation. In addition, the STEM education report prepared by the Ministry of National Education General Directorate of Innovation and Educational Technologies emphasized the need for students to gain innovation skills (MoNE, 2016). In 2018, "Engineering and design skills" were added to the field-specific skills in the MoNE's science course curriculum. The program aimed to provide students with the following skills.

- To gain an interdisciplinary perspective on problems
- To reach the level of invention and innovation
- Creating products by using the knowledge and skills which they have acquired
- Developing strategies that can add value to the products they create (MoNE, 2018a).

STEAM Education Approach

The development levels of the countries are directly related to their economic development. Economic development is possible by producing innovative, creative, and up-to-date products and services. For this reason, countries need new educational approaches to meet the needs of the business world and industrial areas (Howells, 2018). One of these educational approaches is the STEAM education approach that combines different disciplines on the same basis. STEAM education approach gives a chance to students for solving real-life problems like real engineers by using 21st century skills (Sari et al., 2020). In the STEAM education approach, it is aimed those students use science, technology, engineering, art, and mathematics in school, work, social issues, and global initiatives by establishing a relationship between strict academic disciplines and real life. STEAM education approach aims to train scientists, technologists, engineers, and individuals with high innovation skills who will create the new ideas, new products, and industries of the 21st century (Corlu, 2012; Ormanci, 2020; UNESCO, 2019; Yildirim, 2016). According to the report "STEAM Requirements in Turkey Moving Towards 2023" which is released by the Turkish Industry and Business Association (TUSIAD) and PwC Turkey (2017), most of the fastest-growing professions require competencies to be used in STEAM fields. Also, in Turkey, human resources directors think the demand for labor in the STEAM areas will increase within 5 years. In the period of 2016-2023, it was predicted that the STEAM employment requirement will approach 1 million. For this reason, STEAM education has a critical importance for Turkey to find a place for itself in the global innovation race.

Gifted Students

In Turkey, gifted people have an important duty and responsibility in this race. According to MoNE's Gifted People Training Strategy and Implementation Plan (2013) and Vision 2023 (2018b) report, one of Turkey's development goals is increasing opportunities for the gifted to develop their own interests, talents, and creativity and ensuring in order to educate them as beneficial citizens for their country and the world.

For this reason, gifted people should be educated in environments where they can use their potential at the highest level, and this is more important for individuals and society in terms of sociological, psychological, philosophical, pedagogical, economic, strategic, scientific, and technological perspectives (Bilgili, 2000; Ninkov, 2020; Pak & Attepe Ozden, 2018). In MoNE's Science and Art Centers' (SAC) Directive, "gifted people" are described as "academically talented individuals with more competence in creativity, arts, and leadership who learn faster than their peers, who are able to understand abstract ideas, who like to behave independently and who display high performance" (MoNE, 2019). Science and arts centers are the most common institutions providing education for gifted students. As of the last quarter of 2020, approximately 40,000 gifted students of primary, secondary, and high school age are receiving education in 180 science and art centers. The main purpose of the science and art centers, which serve under the MoNE, General Directorate of Special Education and Guidance Services, is to provide gifted students with educational opportunities in line with their interests and to ensure that they use their existing capacities at the highest level (MoNE, 2019). The education of specially talented individuals, who are supposed to have significant influence and authority on issues related to the future of societies, is very valuable for all humanity, and as the education of each individual, it is an important responsibility of contemporary education (Aydogan & Gultekïn Akduman, 2017; Bilgili, 2000; Brown & Wishney, 2017; Ulger & Cepni, 2021).

Another important leg of being in a good position in the global innovation race as a country is to contribute to the talent and potential development of gifted students (Demirhan, 2018). Considering the educational needs of gifted students and the expectations of the business world of the 21st century, the necessity of a quality and continuous STEAM education emerges. STEAM training for special talents enables the acquisition of metacognitive knowledge and skills in talent development (Ulger & Cepni, 2020). However, in our country, despite all personal and partial efforts, the STEAM education

approach for gifted students and educational activities aimed at providing 21st century skills are carried out in a limited and non-academic way (Ayverdi, 2018; Ozcelik & Akgunduz, 2018). In this context, presenting innovative approaches to education for the benefit of students and receiving feedback from students efficiently by teachers who work in the field of education of gifted students in Turkey is important to re-organize the educational content and to know how much of the goals can be achieved. One of the most important elements in the education of gifted peoples is the stage of directing students to the areas of the special skills development program with the multiple assessment method. The planned activities' content must be sufficient and of high quality to achieve this goal. In order to make observations and evaluations in a healthy way, the activities applied at this stage aim to determine the success of the students' performances (MoNE, 2019).

Word Association Test and Drawing-Writing Technique

Word Association Test (WAT) and Drawing-Writing Technique (DWT) are alternative measurement and evaluation tools used in measurement and evaluation (Bahar et al., 1999; Nyachwaya et al., 2011). WAT is one of the most common and oldest techniques used to analyze the cognitive structure of individuals related to concepts and the connections between concepts in this structure, namely the information network, and to determine whether the relationships between the concepts in their long-term memory are sufficient (Atasoy, 2004; Bahar & Ozatli, 2003; Hovardas & Korfiatis, 2006; Yilmaz & Esenturk, 2021). This technique is independently based on the assumption of answering associated with the stimulus word, without limiting the ideas that come to mind (Bahar et al., 1999; Pekel at al., 2019; Sato & James, 1999; Yildizay, 2020).

DWT is useful for obtaining natural and high-quality data about hidden thoughts, understandings, and attitudes regarding these technical concepts (Backett-Milburn & Mckie, 1999; Goldner et al., 2021; Pridmore & Bendelow, 1995). It is seen that DWT is used in many studies in the field of science (Cetin Ozarslan et al., 2013; Nyachwayaa et al., 2011; Pluhar et al., 2009; Shepardson et al., 2007; Yayla & Eyceyurt, 2011; Yorek et al., 2010). With DWT, it is aimed to examine the opinions of gifted students in-depth about the concept of innovation. When the literature is examined, it is seen that almost all of WAT and DWT studies are in the field of science and they are about revealing the cognitive structures and conceptual changes of students (Bahar & Ozatli, 2003; Bahar & Tongac, 2009; Ercan et al., 2010; Kurt & Ekici, 2013; Nakiboglu, 2008).

When the studies conducted on the concept of innovation at the secondary school level are examined, the majority of the studies are related to the determination of the innovation skills of students and their tendencies towards innovation (Akkaya, 2016; Deveci & Kavak, 2020; Karaca, 2011; Kavacik et al., 2015; Seyitogulları & Yalcinsoy, 2016). However, when the relevant literature was scanned, no study investigated the perceptions of gifted students towards the concept of innovation by using WAT and DWT. In light of all the evaluations made, this study aims to examine the perceptions of gifted students towards the concept of innovation by using WAT and DWT. It is thought that the findings obtained as a result of this study will help teachers who teach gifted students, researchers who want to work in this field and prepare curriculum for these students. Also, in this study, it will be revealed whether WAT and DWT, which are used as data collection tools, are sufficient in testing the perceptions of gifted students towards the concept of innovation. In this context, the following problem was sought:

- What are the perceptions of gifted students towards the concept of innovation?

Method

Research Model

This research was prepared according to the qualitative research model and the phenomenology design was preferred within this model. The phenomenological design is used to explain the facts and the meanings attributed to these phenomena (Patton, 2002). Facts are our daily

life experiences, situations, concepts, or perceptions that occur in educational and instructional settings. Phenomenology design is a suitable research design for researchers to investigate phenomena whose full meaning they cannot comprehend (Creswell, 2013, p.14; Yildirim & Simsek, 2016, p.69). In this design, the meanings that a person loads into facts, events, and concepts as a result of individual life experiences and perceptions are examined. Phenomenology has a descriptive identity, not a generalist one (Akturan & Esen, 2008). In this study, the data were analyzed comprehensively. In the study, data were collected with the Word Association Test (WAT) in order to reveal the cognitive structure of the students towards the concept of "innovation". In the data collection form, both written and visual (drawings were requested) feedback was received from the participants.

Study group

The criterion sampling method, one of the purposeful sampling methods, was preferred in the formation of the study group. In order to collect detailed and high-quality data about the concept, it was taken into account that the students participated in STEM education processes. In this way, the working group was formed with the participation of 25 (15 male, 10 female) gifted students registered in a science and art center in Ankara in the 2018-2019 academic year. These students previously participated in an 8-week workshop (application) program based on the STEM education approach, in which concepts for science education are carried out with applications based on engineering and technology design.

The applications were carried out in the STEM workshop, whose content was created by the researcher. The STEM workshop training program has been prepared by establishing a relationship between the real-life problem and content, ensuring the integration of Science, Mathematics, Technology, and Engineering. It is also aimed to realize scientific process skills and meaningful learning in creating a STEM workshop training program. The application process of the research was conducted by one of the researchers as a teacher of the course for 8 weeks with 3 hours of lessons per week. In addition, support was received from visual arts and mathematics teachers. Activities, planned and implemented by researchers in accordance with secondary school science course achievements applied to students are given by creating a discussion environment for the problems related to daily life. The students carried out the activities in groups of four people. In this study, activities related to simple machines and energy transformations, which are subjects of the science course, were carried out within the scope of the STEM training program. In addition, students are expected to look at events through the windows of Science, Technology, Engineering, and mathematics and gain a common perspective on these areas. Four different STEM activities were performed in this study. Each activity was scheduled as 6 lesson hours. Activities were held in the order given below.

- Skateboard track
- Newton's Car
- Clean Energy Clean World
- Engineering for Technology

The activities were carried out in the following stages.

1. Entry was made with a visual and a problem situation related to the visual or an event based on daily life. In this process, students were directed to think and inquire about problem situations from real life. Video, simulation, animation, etc. contents were also used to introduce the problem and the problem situation and to attract the attention of the students.

2. At the end of these processes, students were asked to use their creative thinking skills and share their design ideas for the solution of the problem.

3. The students were directed to search for resources and content from different media with the questions asked about the content. Necessary information about literature review methods was given by the teacher.

4. Afterward, the teacher determines the framework of the content and scope by giving special field information suitable for the purpose of the study. Contents and scope are given within the framework of gains related to energy conversions for Skateboard Track activity, Newton's laws of motion for Newton's Car activity, conversion of motion energy to electrical energy for Clean Energy Clean World activity, and energy transformations for Engineering for Technology activity.

5. The students were asked to formulate their hypotheses, then to reveal possible solutions together with the brainstorming and drawing process for the designs of the models they claimed to test their hypotheses, and to test their variables with simulation programs.

6. In the light of the data and information obtained from the simulations, the physical construction phase of the models they produced has started.

7. In the light of the data obtained after the simulation, experiment, and construction process, the students presented the mathematical models for the solution of the problem under the guidance of the mathematics teacher. Students were asked to explain and define the concepts that constitute the basis for the solution of the problem through group discussion by using the information they obtained from the resource search process.

8. Students were asked to associate the concepts they learned with daily life, technology, engineering, and different fields. It has been discussed which engineering fields can work in the creation of these designs. Interdisciplinary emphasis was made by asking which branches of science were used in the process of solving the problem and creating products.

9. During the evaluation process, the groups were asked to present their products in a classroom environment. In addition, the evaluation phase was evaluated in three different aspects as the learning process, content, and product: What the students learned by themselves and what their groupmates learned up to this stage? Which physical and mathematical concepts they reached in the solution of the problem? What kind of changes would it make if you were to create this mechanism again? Reason? Students were asked to evaluate their work by giving written feedback forms including such questions and designs were evaluated with product evaluation rubrics.

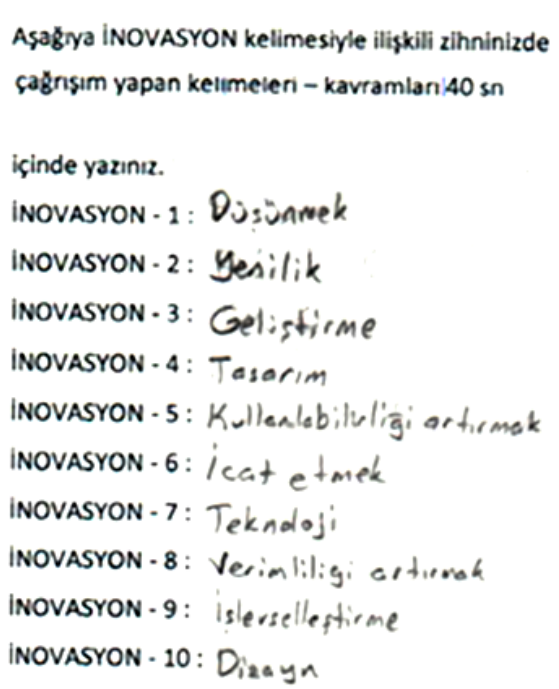
Data Collection Tool

Word Association Test

In this study, Word Association Test (WAT) was used as a data collection tool. In addition, in order to provide data diversity (Patton, 2002; Poggenpoel & Myburgh, 2003), students were also asked to draw on the concepts and sentences they wrote. Data diversity (triangulation) is one of the important factors affecting the quality of studies (Fraenkel et al., 2011). The data were taken in a single form for ease of use, integrity, and preventing data loss. During the study, participants were informed about how to use the form in which they will express their perception of the concept of "innovation". The concepts, sentences written by the students, and the visuals they drew were analyzed together. Word association test is an alternative data collection tool that has been used and used in many studies to reveal students' perceptions, cognitive structures, and the connections between concepts in this structure (Bahar et al., 1999; Celikkaya & Kurumluoglu, 2019; Ekici & Bilici, 2016; Kostova & Radoynovska, 2008; Nacaroglu & Arslan, 2020; Ozatli & Bahar, 2010; Ozturk & Ozcan, 2017; Polat, 2013). While creating the WAT, it is aimed to reveal the perceptions of gifted students about the concept of innovation in this study, so the keyword/concept has been determined as "innovation". In order to avoid the risk of a chained response (Bahar & Ozatli, 2003), it was written ten times words one under the other, leaving sufficient gaps in length in front of each concept so that participants could write their answers. If the student does not return to the key concept in each concept writing, s/he can write different words instead of the key concept, in this case, it may prevent the test from achieving its purpose.

Figure 2

Sample Word Association Test (S1)


Aşağıya İNOVASYON kelimesiyle ilişkili zihninizde çağrışım yapan kelimeleri – kavramları 40 sn içinde yazınız.

İNOVASYON - 1 : Düşünmek
İNOVASYON - 2 : Yeşilik
İNOVASYON - 3 : Geliştirme
İNOVASYON - 4 : Tasarım
İNOVASYON - 5 : Kullanılabilirliği artırmak
İNOVASYON - 6 : İcat etmek
İNOVASYON - 7 : Teknoloji
İNOVASYON - 8 : Verimliliği artırmak
İNOVASYON - 9 : İşlerselleştirme
İNOVASYON - 10 : Dizayn

Write down the words and concepts associated with the word Innovation in 40 seconds.

Innovation-1	Thinking
Innovation-2	Newness
Innovation-3	Development
Innovation-4	Design
Innovation-5	Increasing Usability
Innovation-6	To invent
Innovation-7	Technology
Innovation-8	Increasing productivity
Innovation-9	Functionalize
Innovation-10	Dizayn

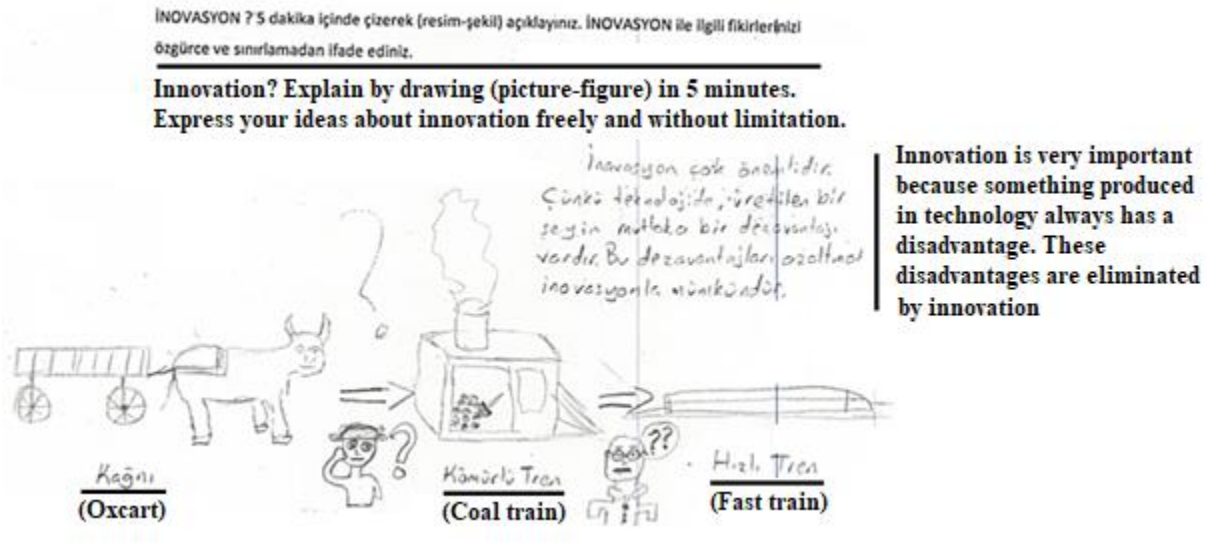
Word association test consists of two stages as seen in figure 2. When the studies related to the WAT are examined, it is understood that the time given to the students to answer the stimulating key concept varies between 30 seconds and 75 seconds in the first stage (Bahar & Ozatli; 2003; Gussarsky & Gorodetsky 1990; Kurt, 2013a). This period may vary depending on the student level. WAT was administered to three students who out of the study group as a pilot before the study. After the pilot application, it was observed that 40 seconds was sufficient for the word association test for the students. Before starting the application, explanations about WAT were made and a sample activity was made for different concepts. After distributing the WAT form to students, it was stated that they had 40 seconds to respond to the key concept, 1 minute to write sentences, 5 minutes to draw pictures/figures, and the application was initiated. The teacher kept time for the students to complete the stages within a certain period for each stage and checked the students' starting and finishing at the same time. At the first stage of the test, the students were asked to write down the relevant concepts that the concept of "innovation" brought to mind as a result of the connotation they made in their minds within 40 seconds.

Drawing-Writing Technique

This technique is a qualitative data collection technique that involves the participant drawing a picture and writing down his thoughts and ideas about this picture to explain a research question or a phenomenon (Bradding & Horstman, 1999). In the third stage of data collection, the technique of drawing-writing was used. Students were asked to explain the concept of innovation by drawing (picture/figure) within five minutes (Figure 3).

Figure 3

Drawing-Writing Technique (S1)



Students were asked to "draw and write what the concept of innovation means" by providing the necessary time and environment.

Drawing technique has been used in science education (Balim & Ormanci, 2012; Yilmaz & Yanarates, 2020), education of special talent (Yilmaz & Guven, 2015) and many studies (Aykac, 2012; Ekici, 2016; Kalvaitis & Monhardt, 2012; Sewell, 2011) used and still in use.

In some studies, participants were asked to draw only and, in some studies, both draw and write (explain their drawings). In this study, participants were asked to both drawings and explain (write) drawings. With the drawing technique, the individual is able to reveal his hidden feelings and thoughts comprehensively and expressing the fact, emotion, thought concept, belief or information by using visual elements in an easier, understandable, and entertaining way. In this way, more understandable, qualified, descriptive, and purposeful data can be obtained (Backett-Milburn & McKie, 1999; Chang, 2012; Kalvaitis & Monhardt, 2012; Kurt, 2013b).

Analysis of Data

In the study, the data obtained by the word association test were analyzed by using the descriptive analysis method. Descriptive analysis is the process of presenting data according to previously determined themes. In this context, data can be arranged according to the themes revealed by the research questions (Yildirim & Simsek, 2013). Content analysis is a scientific approach that is based on gathering similar data from all kinds of data sources such as verbal, written concepts and documents, drawings, within the framework of certain codes, categories and themes, and understandably interpreting them, in order to reach concepts and relationships that can explain the data (Lichtman, 2010; Yildirim & Simsek, 2016). In addition, data analysis diversification was made in this study (Denzin, 2009; Patton, 2002). Data obtained by word association test and drawings were analyzed together. The data collected by both WAT and DWT were compared and correlated according to the purpose of the study. Before starting the analysis of the data, students' data forms were numbered as S1, S2, ... S25. The concepts formed as a result of the connotations given to the key concept are listed and a frequency table showing the repetition numbers of each connotation has been created. Unrelated and once repeated words were not evaluated (Kostova & Radoynovska, 2008). Response ranges were determined and listed by using the cut-off point technique (Bahar & Ozatli, 2003). In this technique, there were between 10 and 5 points below of the most repeated answer words

in the frequency table given for any key concept in the WAT is used as the cut-off point and the answers above this response frequency are written in the first part of the map. Then the cut-off point is pulled down at regularly and the process continues until all keywords appear in the concept network (Nacaroglu & Arslan, 2020). The concept networks were also prepared in this way in this study (Ozturk & Ozcan, 2017). The cut-off point was determined as 20 and above in this study. In addition, each cut-off point was pulled down in every five units and concept networks were drawn by the answer words at each cut-off point.

The drawing-writing data obtained from the drawing-writing technique were also analyzed according to the content analysis method. The drawings and explanations of the students regarding the concept of innovation are collected in certain categories and codes. In addition, the opinions of the students which reflect the best each category related to innovation in the drawing-writing technique's text part were directly conveyed in quotes by specifying the participant number. Examples of drawings of participating students related to innovation in drawing-writing technique were also given in the text by indicating the participant number such as S10 and S4.

In general, the data analysis and interpretation stages of this study were carried out in the following order:

- Structural analysis of data forms.
- Elimination of forms which are not suitable for evaluation.
- Numbering evaluated data forms answered by the students from 1 to 25 as S1, S2, ... S25.
- Determination of the codes of the forms which are suitable for evaluation.
- Developing category and sub-category
- Determining the distribution of the codes into categories and sub-categories by examining them.
- Performing studies on validity and reliability.
- Calculation of the frequencies of the obtained codes.
- Interpretation of the data.
- Writing the study report.

In order to ensure the validity of the research, the coding of the data and how the conceptual category is reached in the process of data analysis are explained extensively. In addition, student opinions obtained from the data in the study that best reflect each category are included in the findings section (Yildirim & Simsek, 2016). It has been attempted to ensure consistency between the relevant literature and the research on this subject in the comments (Yasar, 2018). The conclusion and discussion part of the study was discussed by comparing the findings with the studies in the literature. For the reliability of the study, the codes of the two researchers and the categories related to the codes were compared in order to verify whether the codes given under the categories in the study represented these conceptual categories. In addition, at this stage, codes were created based on the opinions of two experts. After the research data is encoded separately by two researchers, the resulting list of codes and categories is given its final form. The reliability of the data analysis conducted in this manner was calculated by using the formula of [Agreement / (Agreement + Disagreement) x 100] (Miles & Huberman, 1994). The average reliability between the coders was calculated as 88.80% for the Word Association Test (WAT) and 90.90% for the Drawing-Writing Technique (DWT).

Since the working group consists of gifted students who participated in the 8-week workshop process, long-term interaction was established with the application students. This is a situation that makes a positive contribution to the credibility of the study. The form was filled in a sincere environment by creating a conversation atmosphere in a way that would not go away from the subject. During the study, the necessary information was given to the participants on how to use the form in which they will reveal their perceptions about the concept of "innovation". Participant confirmation has been received. Audio and video recordings were not taken from the students. It has been emphasized several times that volunteering is essential in their participation in the study and that they can leave the study whenever they want. Parents of participating students were informed,

and parental permission was obtained. It has been stated that participating in this study will not put them ahead or backward from the students who do not participate. It was stated that if they want to leave the study, it is sufficient for them to just say this. It was also stated that if they stop working, they will not face any negative situation. It was stated that the type of interview questions could not have any negative effect on the participants.

The examination of the extent to which the form serves the purpose, its applicability, and comprehensibility was conducted by a faculty member specializing in STEM education and a faculty member specializing in science education. It was concluded that the study results could be transferred to situations in similar participants and environments, and a detailed description was made.

Finding

Findings Regarding the Word Association Test (WAT)

Seven (7) categories were created from the words (concepts) that emerged from the connotations of the keyword "innovation" in the students' minds. Studies conducted in this area were also used when creating categories (Aslan, 2018; Azar & Ciabuschi, 2017; Gunay & Calik, 2019; Incebacak et al., 2018; Kocak, 2018; Ozcelik, 2019). These categories and the words answered in each category and their frequency distribution were listed in Table 1. If words are repeated once, they are not combined with other words and are not included in categories. These words have been removed from Table 1 in terms of the nature of the research and indicated in the relevant comments section at the end of each category. As a result, 38 words related to the concept of innovation and 7 related categories were created.

Table 1

WAT Test's Association Words and Frequency Distribution for Innovation Concept

Categories	Codes	(f)	Frequency Total
Definition and Characteristics of Innovation	Newness	24	78
	Development	20	
	Improvement	18	
	Change	9	
	Increasing productivity	5	
	Risk	2	
Innovation and Development	Technology	18	52
	Modernization	7	
	Science	5	
	Progress	5	
	Industry	4	
	Education	4	
	Developed country	4	
	Revolution	3	
	Energy	2	
Stages of Innovation	Design	8	46
	Production	8	
	Product	8	
	Marketing	8	

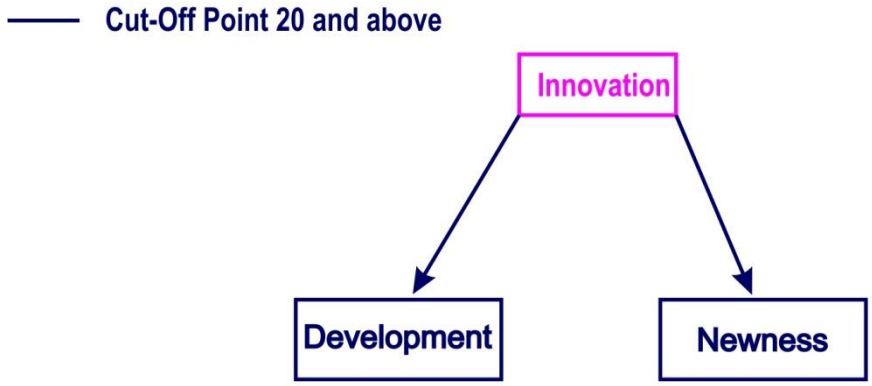
	Process	4	
	Idea	4	
	Problem	3	
	Project	3	
Innovation and Business	Company	10	27
	Trade	9	
	Engineer	5	
	Scientist	3	
Skills for Innovation	Thinking	8	18
	Creativity	4	
	Entrepreneurship	3	
	Imagination	3	
Innovation and Product	Technological Product	13	17
	Internet	2	
	Software	2	
Other (Non-Category Concepts)	To invent	7	13
	Science fiction	2	
	Subconscious	2	
	Human Benefit	2	
Total	38 Words		251

As a result of the analysis of the data obtained from the word association test, 7 categories were created from the concepts arising from the mental perception of gifted students towards the concept of innovation. These were listed in descending order according to their frequency sum that definition and characteristics of innovation (f = 78), innovation and development (f = 52), stages of innovation (f = 46), innovation and business (f = 27), skills for innovation (f = 18), innovation and product (f = 17), other (non-category concepts) (f = 13).

When Table 1 is examined, it is seen that gifted students produce 38 different answer words in 7 categories from the concepts that emerge after the mental associations for the keyword "innovation" in their minds, and the concept of "newness" (f = 24) is the most repeated. Concept networks were constructed according to the answer words related to the key concepts in Table 1. Since repeated words in the table have a frequency of 5 and above, cut-off points were determined as 5 and multiples. Concept networks were constructed by using cut-off points. The concept networks at each cut-off point are shown in different colors. Accordingly, the concept network created for cut-off point 20 and above is seen in Figure 4:

Figure 4

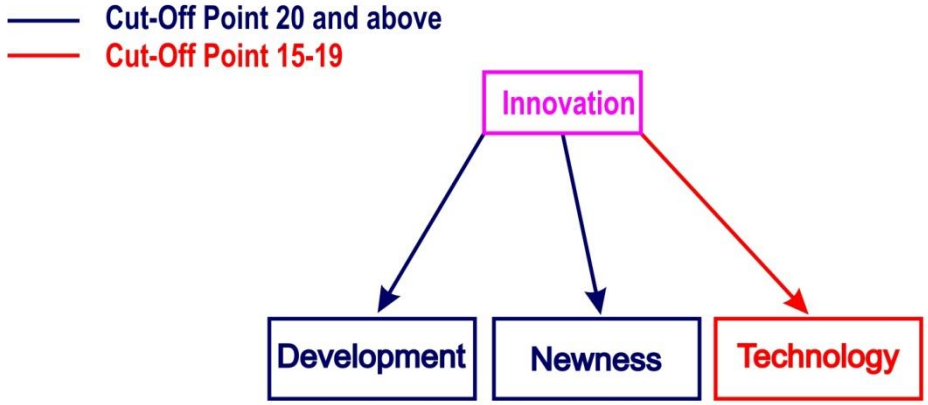
Concept Network Created According to Key Concepts (Cut-off Point 20 and Above)



As seen in Figure 4, keywords were emerged at cutting point 20 and above are "newness" and "improvement". The concept network for cut-off points 15 – 19 is given in Figure 5.

Figure 5

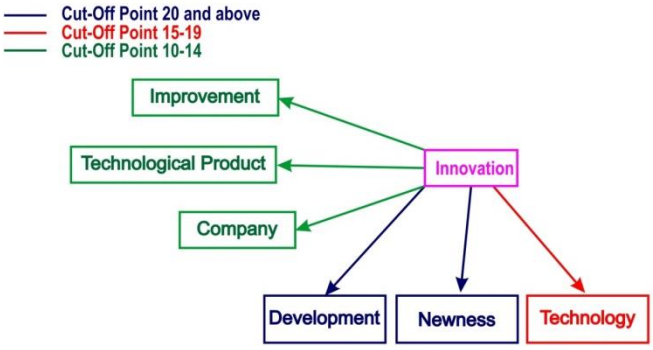
Concept Network Created According to Key Concepts (Cut-off Point 15-19)



As seen in Figure 5, keywords that emerged at the cutting points between 15 – 19 are "technology". The concept network for cut-off points 10-14 is given in figure 6.

Figure 6

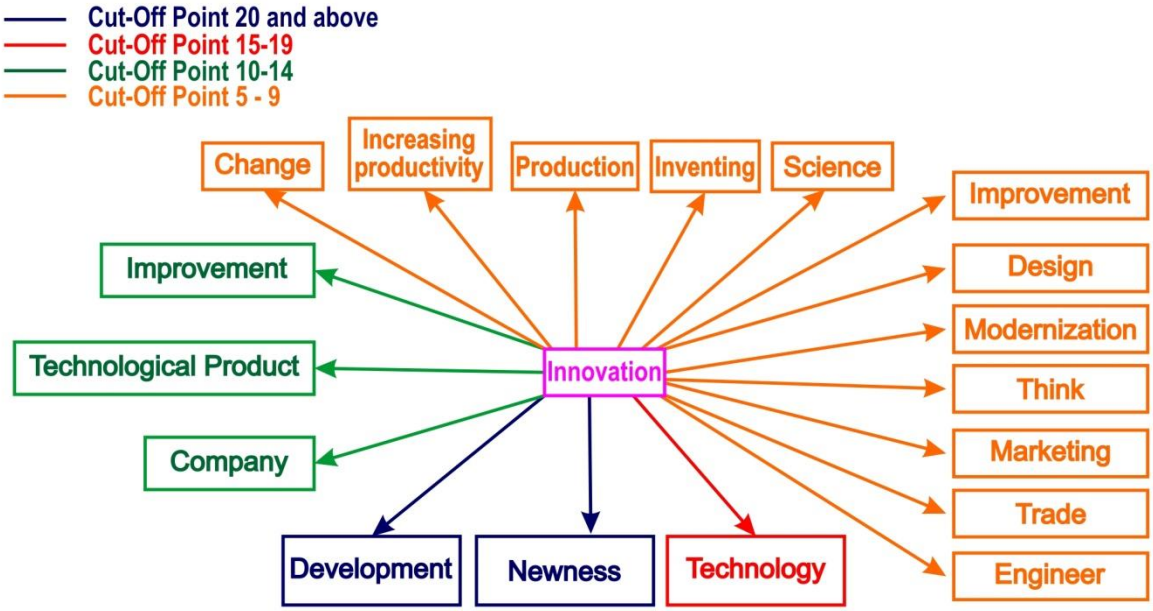
Concept Network Created According to Key Concepts (Cut-off Point 10 – 14)



As seen in Figure 6, keywords that emerged at the cutting point between 10 – 14 are "Improvement", "company" and "technological product". The concept network for cut-off points 5 – 9 is given in Figure 7.

Figure 7

Concept Network Created According to Key Concepts (Cut-off Point 5 – 9)



As seen in Figure 7, keywords that emerged at the cutting points between 10 – 14 are "Change, increase productivity, modernization, science, progress, design, production, marketing, trade, engineer, thinking, inventing". In addition, the answer words produced by gifted students for the concept of innovation were expressed as a whole using the concept cloud technique. The resulting concept cloud is given in Figure 8.

Figure 8

Word Cloud for the Innovation Keyword

Findings Regarding the Drawing-Writing Technique

The drawings and the sentence examples of the students regarding the concept of innovation were given below with direct quotations according to their categories.
Figure 9 and Table 2 are examples of drawings and sentences belonging to the category of definition and characteristics of innovation.

Figure 9

Example of Drawing Belonging to the Category of Definition and Characteristics of Innovation

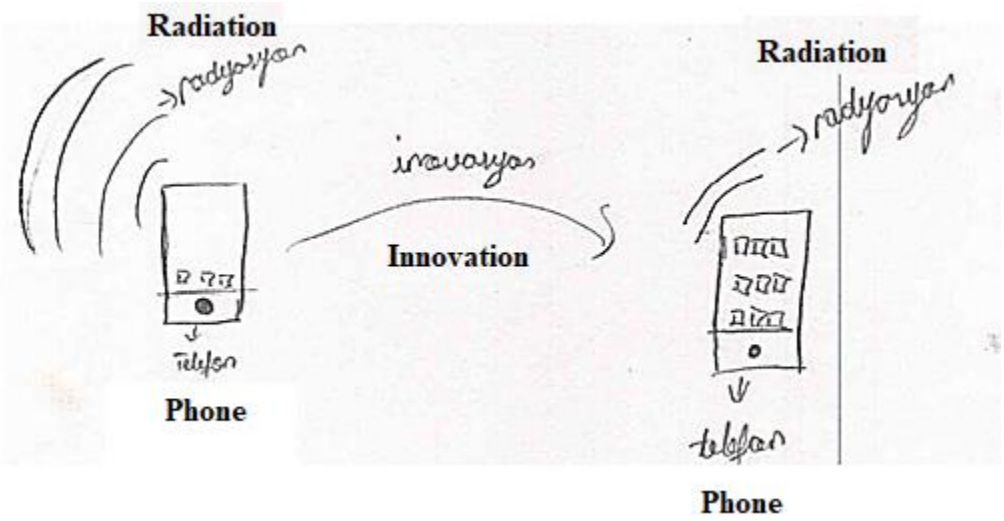


Table 2

Example of Sentences Belonging to the Category of Definition and Characteristics of Innovation

Student	Sentence
S4	*"Innovation is newness. It is to improve the old one and make it more useful. It is to produce a more useful product and present it to the market…. "*

Figure 10 and Table 3 are examples of drawings and sentences belonging to the category of innovation and development.

Figure 10

Example of Drawing Belonging to the Category of Innovation and Development

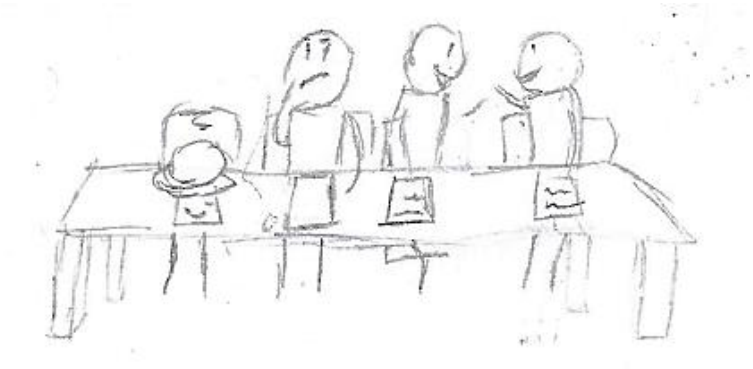


Table 3

Example of Sentences Belonging to the Category of Innovation and Development

Student	Sentence
S18	*"Because innovation is about newness, it is also important that we receive innovative trainings like (STEM)."*

Figure 11 and Table 4 are examples of drawings and sentences belonging to the category of stages of innovation.

Figure 11

Example of Drawing Belonging to the Category of Stages of Innovation

Turkish :	English :
Soru sorma	Asking question
Düşünme	Thinking
İzleme/Gözlem	Observation

Table 4

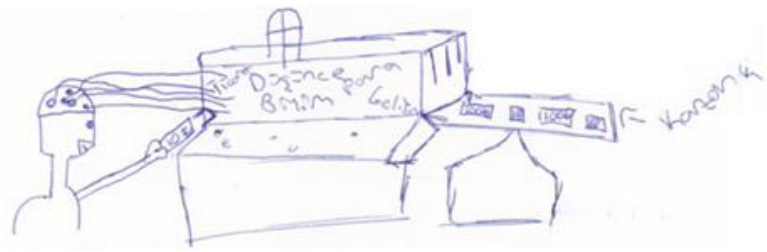
Example of Sentences Belonging to the Category of Stages of Innovation

Student	Sentence
S25	*"... this renewal process continues until a new idea is found."*

Figure 12 and Table 5 are examples of drawings and sentences belonging to the category of innovation and business.

Figure 12

Example of Drawing Belonging to the Category of Innovation and Business



Turkish :	English :
Ticaret	Trade
Düşünce	Idea
Para	Money
Gelişme	Development
Kazanç	Income

Table 5

Examples of Sentences Belonging to the Category of Innovation and Business

Student	Sentence
S17	*"Innovation provides the opportunity to produce a lot in less cost and time."*

Figure 13 and Table 6 are examples of drawings and sentences belonging to the category of skills for innovation.

Figure 13

Example of Drawing Belonging to the Category of Skills for Innovation

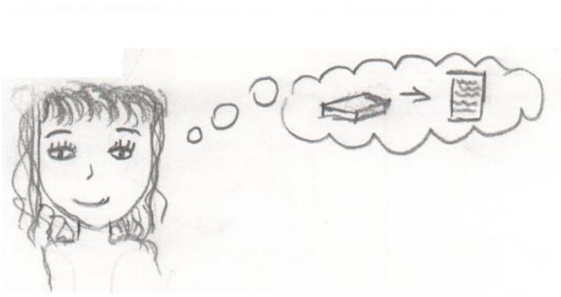


Table 6

Example of Sentences Belonging to the Category of Skills for Innovation

Student	Sentence
S12	*"To find a solution or improve the product by changing our thoughts for a problem or any problem created by a product."*

Figure 14 and Table 7 are examples of drawings and sentences belonging to the category of innovation and product.

Figure 14

Example of Drawing Belonging to the Category of Innovation and Product

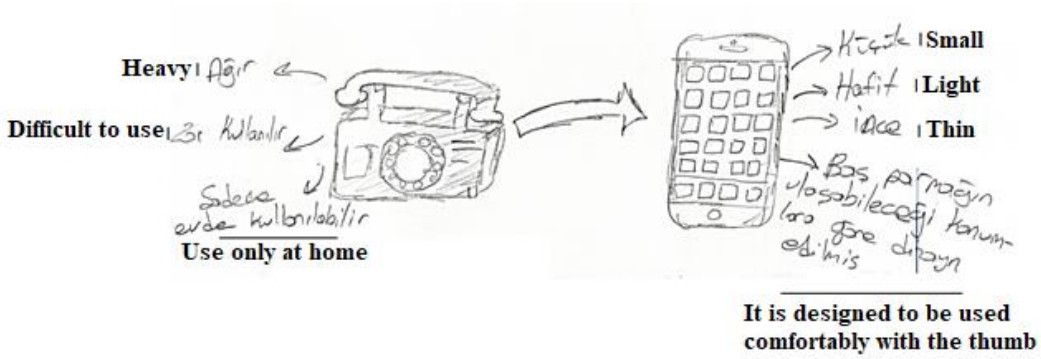


Table 7

Example of Sentences Belonging to the Category of Innovation and Product

Student	Sentence
S19	*"Innovation is a concept that means development and newness so enables a handset phone to turn into a mobile phone."*

Figure 15 and Table 8 are examples of drawing and sentences belonging to the category of Other (Non-category concepts)

Figure 15

Example of Drawing Belonging to the Category of Other (Non-Category Concepts)

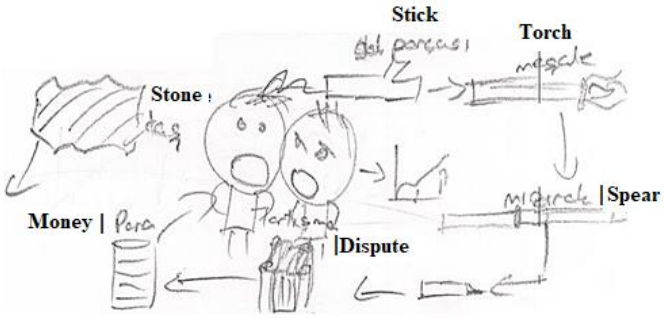


Table 8

Example of Sentences Belonging to the Category of Other (Non-Category Concepts)

Student	Sentence
S3	*"Scientists make new discoveries by examining the environment."*

Students also made drawings and wrote sentences about the concepts mentioned. Table 9 shows the findings and frequency values of the categories obtained by the drawing-writing technique for the concept of innovation. The categories developed separately for both sections were examined according to findings that complement, elaborate, explain, and similar. The interrelated categories determined as a result of this examination are given in Table 9.

Table 9

Findings by WAT and DWT for The Concept of Innovation, According to Common Categories

Common Categories	DWT Items	WAT (*f*)	Drawing (*f*)	Writing (*f*)
Definition and Characteristics of Innovation	Newness	24	2	2
	Development	20	3	2
	Improvement	18	1	2
	Change	9	1	-
Innovation and Development	Technology	18	-	1
	Modernization	7	1	1
	Science	5	-	1
	Education	4	1	1
	Energy	2	1	-
Stage of innovation	Design	8	1	-

	Production	8	-	2
	Product	8	2	1
	Process	4	5	-
Innovation and the Business	Trade	9	2	3
	Engineer	5	-	1
Skills for Innovation	Imagination	3	1	1
Innovation and Product	Technological Product	13	3	3
Other (Non-Category Concepts)	To invent	7	1	2
	Science fiction	2	-	1
	Human Benefit	2	-	1
Total	20 Words	176	25	25

When Table 9, which contains the findings on the distribution of categories obtained by word association and drawing-writing technique for the concept of innovation, is examined, it is seen that the cognitive structures emerging in the students' drawings are supportive and explanatory for their cognitive structures determined by the word association test.

Gifted participant students mostly focused on the concepts of “newness”, “development”, “technology” and “technological product” in drawing and writing technique. In most of the categories, the smartphone was drawn in general, and the concept of innovation was tried to be explained through this visual drawing in different categories.

Conclusion and Implications

This study was conducted to determine the perception (cognitive structure) of gifted students towards the concept of innovation. According to our literature scan, there is no other study in which the concept of innovation is examined with word association and drawing and writing technique. As a result of the analysis of the data obtained from the study, it was determined that the students produced many words, used them in sentences, and made drawings. When the data obtained by using the cut-off point technique as a result of the word association test, it was determined that 25 gifted students who voluntarily participated in the study produced 38 different words related to the concept of "innovation" at 251 times. This result reveals that the perceptions of innovation of gifted students vary. Within the scope of the study, 7 categories were determined totally in the conceptual structures of the students regarding the concept of innovation. The category in which they produced the most concepts related to their cognitive structures was the definition and characteristics of innovation. Other categories are listed as innovation and development, stages of innovation, innovation and business, skills of innovation, innovation and product. When the studies in the literature are examined, it is seen that the concept of innovation is associated with the concepts of product, process, technology, change, leadership, questioning, taking risks, being open to new ideas, development, progress, realization conditions, functionality, strategic individuals, effective teamwork, communication, entrepreneurship, and creativity (Bayrakci & Eraslan, 2014; Bulbul, 2012; DiGironimo, 2010; Duran & Saracoglu, 2009; Incebacak et al., 2018; Ozyurek & Tuncer, 2003). When the connotation words for the concept of innovation obtained from the students' word association test are examined, it is seen that the words “newness”, “development”, “technology” and “technological product” are mostly associated (Figure 6). It was observed that the gifted participant students mostly focused on the concepts of "innovation", "development", "technology" and "technological product" in their drawings and writings taken with the DWT test. It is seen that this relationship is in harmony with the literature and supports the results that are obtained from the study.

In the category of innovation and development, the concept of innovation has evoked the concepts of technology, modernization, science, education, and industry in students. Aslan (2018) defines innovation as making newness on technological product and commercialize it and the

development of a country in the fields of science, education, and industry depend on the innovation capacity of that country. It can be said that this explanation supports the answer words given by the students and the category created. The category of stages of innovation is constructed with answer codes “Design, production, product, marketing, process, idea, problem, and project". In most of the drawings and explanations, students depicted smartphones and computers, and they tried to explain the concept of innovation through these images. These answer words and their relationship to each other show that students have awareness and knowledge about engineering design processes and project-based applications. Based on this result, we can say that it is due to the fact that gifted students have participated in the support education process in science-art centers with project-based, practical, innovative learning approaches (MoNE, 2019; Sahin, 2018). It can be interpreted that focusing on subjects such as engineering, entrepreneurship, and innovation and the inclusion of activities such as "engineering and entrepreneurship practices" and "organizing science fairs" which started to be implemented in the science curriculum as of 2018 in Turkey is effective in increasing the perception and knowledge level towards these results (MoNE, 2018a). This situation reveals the importance of increasing students' awareness levels and skills regarding 21st century skills. This can only be achieved by using alternative measurement tools to help teachers organize and plan educational content and environments before and after education. In this respect, It is important for the quality of education that teachers use measurement tools such as word association test (WAT) or drawing - writing test (DWT), which can be practical, multi-dimensional data can be obtained and appeal to many senses of students in their learning processes (Bahar et al., 1999; Balbag & Karademir, 2020; Celikkaya & Kurumluoglu, 2019; Ekici & Bilici, 2016; Kostova & Radoynovska, 2008; Kurt, 2013b; Nacaroglu & Arslan, 2020; Ozatli & Bahar, 2010; Ozturk & Ozcan, 2017; Polat, 2013).

As a result of the WAT, the concept of innovation was associated with the word “inventing" (f = 7) by students. When examining student drawings and written sentences, 1 drawing and 2 sentences (writing) were reached in the code “inventing”. This shows that the concept of innovation is misunderstood by some students (Aslan, 2018; Gunay & Calik, 2019, p.8; Ozcelik, 2019). In the literature, there are many studies in which these two concepts are frequently used interchangeably. In this study, the concept of innovation and the concept of "inventing" were associated incorrectly with each other in the tests with the rates of 28% in WAT, 4% in drawings, and 8% in sentences. It is understood from these low-test results that gifted students have high cognitive perception and awareness of the concept of innovation. Incebacak et al. (2018) found that approximately three-quarters of the teachers do not know the Turkish equivalent of innovation and cannot associate it with the concept of newness in their study that was conducted to determine the perspective of classroom teachers on the concept of innovation and innovation in education. When the findings obtained from this study carried out with gifted students at the secondary school level are examined, it is observed that students know the closest meaning of the concept of innovation to its Turkish equivalent by responding to the concept of innovation with the concept of "newness" (f = 24) (Gunay & Calik, 2019, p.6; Kilicer, 2011) and they associate with the concept of innovation in their mental structure. This may be due to the fact that the educational environment and content offered to gifted students are designed according to innovative learning approaches (Yildirim & Selvi, 2018, p.48).

Inclusion and application of entrepreneurship, creativity, and innovation concepts in the educational curriculum will increase students' mental perception and motivation towards 21st century skills. Systematic efforts in education should be increased in order to gain 21st century skills. One of the most important changes to be made in the educational content should be to include more 21st century skills in practice. In order to raise individuals who, have an innovative perspective in transforming knowledge into life skills, thinking creatively and differently, producing new technologies, not imitating existing technologies, but striving to develop them, it is necessary to include more activities in the content of education that will improve creativity and innovation.

Suggestions

In line with the results obtained in this study, the word association test can be used as a diagnostic tool in the education of the gifted individual. Teachers can use the results of WAT tests as an auxiliary measurement tool in determining students' learning, mental structures, cognitive level of previous learning, and in the process of student orientation in science-art centers. It can also help teachers plan before and after teaching. In addition, WAT can make it easier for teachers to reach larger groups or private study groups in a very short time.

This study was carried out to analyze the cognitive structures of gifted students on the basis of the concept of innovation. Comparative analysis can be done by applying the form to students at different grade or program levels. The data obtained after these analyses will make significant contributions to the education literature of gifted students which is still tried to be newly structured in terms of program, content, and effectiveness.

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