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# WHAT A DRAWING TEST CAN SAY? A SYSTEMATIC REVIEW OF DAST STUDIES IN TURKEY

*Research article*

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# WHAT A DRAWING TEST CAN SAY? A SYSTEMATIC REVIEW OF DAST STUDIES IN TURKEY

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**Abstract**

In this study, we examined 32 journal articles in which measurement tools such as DAST, DAST-C, etc. were used to reveal the views of scientists in science education in Turkey. According to the findings obtained from the systematic review, research has been intensified since 2013, data were collected from small student groups in a short time, no data on two important regions of the country could be determined, and a uniform data collection tool was preferred, and the studies focused on the 5th and 8th-grade levels. In addition, it was determined that students from the kindergarten level to the 8th-grade level generally have stereotypical views toward scientists. The results revealed in the research stated that this situation stems from the media, culture, gender effect, field of study, teacher, family, curriculum, textbooks, social life, and the word scientist that emphasizes the male gender-specific to Turkey. It can be said that the recommendations in the studies are for the determined factors. The results of the study also include gifted students. In this respect, the research gives an idea about the design and future direction of research that uses the views of scientists in science education.

*Keywords:* DAST, science education, systematic review

## 1. Introduction

It is an undeniable fact that science is necessary for civilizations and is directly related to the level of development of countries. It is important in which direction the society's point of view towards science is and positive social awareness towards science will also positively affect the development of societies. It is necessary to start this awareness at an early age. Adequate recognition of science and its practitioners will create positive awareness in students. Students' perceptions of science and scientists are substantive for the development of scientific literacy (Akerson et al., 2017). Negative attitudes towards science and scientist may cause to decrease in the number of students studying science at advanced levels. Therefore, directing pupils' perceptions about scientists play a crucial role in their future careers (Buldu, 2006). To Finson (2002), students' images of the scientist influence choosing profession in science since there is a strong relationship between the perception of scientists and the attitudes toward science. Science education has a key role to canalize students toward scientific fields.

In this context, many tools have been developed to determine both the student's views of the nature of science and scientists such as questionnaires (Kind et al., 2007; Silver & Rushton, 2008), drawings (Chambers, 1983), illustrations (Boylan et al., 1992) and interviews (Erten et al., 2013; Samaras et al., 2012). Mead and Meatrux (1957) take the first place in the historical development of the subject and in 1957 they evaluated the perceptions of 35000 high school students with open-ended questions. Then, Krajkovich (1978) revealed that a different scale had to be prepared and in 1982, Mead and Metraux designed the "Science and Scientist Perception Scale", and students were not eager to write down and had difficulties expressing their feelings, that scale was not efficient to determine their opinion. Nevertheless, drawing was considered to be an effective learning strategy since students can construct verbal and nonverbal information (Hsieh & Tsai, 2018). Especially among K-12 students, drawing in science education can act as methodological assessments that help find out their ideas (Harris et al., 2014). Fiorella and Zhang (2018) reviewed the numerous uses of drawings as learning strategies.

DAST, developed by Chambers, (1983) emerges as a measurement tool in which perceptions about scientists are measured based on drawings and has been used too often by researchers to determine perceptions of scientists recently. In 5–11 years old students' conceptions of scientists, Chambers (1983) defined seven characteristics as lab coats, eyeglasses, facial hair, symbols of research, symbols of knowledge, technology, and relevant captions. Following Chamber's work, DAST analysis framework was modified by Finson et al. (1995) with eight additional indicators (male gender; Caucasian indications of danger; the presence of light bulbs; mythical stereotypes; indications of secrecy; scientist doing work indoors; and middle-aged or elderly scientist) and this new version of analysis was named as the Draw A Scientist Test Checklist (DAST-C). It enables researchers to get quantitative data to code and evaluate the stereotypes by analyzing students' drawings and filling in that checklist.

Many studies have common points for the characteristics of the scientists, and they reported that students describe scientists according to the positivist understanding of science (Blagdanic et al., 2019; Chionas & Emvalotis, 2021; Emvalotis & Koutsianou, 2018; Medina-Jerez et al., 2010; Meyer et al., 2019; Sharma & Honan, 2020; She, 1995). For instance, according to students' views, scientists should wear a lab coat (Akçay, 2011; Chambers, 1983; Meyer et al., 2019) put on eyeglass (Hayes et al., 2020), have a growth of facial hair (Çakmakçı et al., 2010), use flasks or test tubes (Laubach et al., 2012) have technology symbols such as a computer (Fung, 2002) and use formulae or taxonomic classification (Sharma & Honan, 2020) while they are studying. Also, students describe scientists who work indoors (in laboratories), male, elderly, or young mostly who is white chemist (Chambers, 1983; Ju et al., 2009). Besides this, scientists are demonstrated to work secretly in laboratories; they are clever, lonely, dangerous, and unable to control what they found; they even have some mental issues (Finson, 2002; Haynes, 2003; Rubin et al., 2003; Song & Kim, 1999). Many factors are cited as the reason for the emergence of these stereotypes which are common and difficult to break, such as mass media, movies, comics, cartoons, children's books, educational programs, and textbooks (Flicker, 2008; Haynes, 2003; Locke, 2005; Long & Steinke, 1996; McAdam, 1990; Schibeci & Sorensen, 1983; Schummer & Spector, 2008; Song & Kim, 1999; Steinke, 2005; Weingart, 2008).

Initial studies were carried out in America and Canada (Chambers, 1983; Parsons, 1997; Finson, 2002) but many studies were carried out in different parts of the world such as Europe (Reinisch et al., 2017; Thomas et al., 2006) Asia (Kenneth Jones & Hite, 2020; Narayan et al., 2013), Africa (Meyer et al., 2019; Ramnarain & Senoelo, 2011), Russia (Razina &

Volodarskaya, 2018), Oceania (Sharma & Honan, 2020), Baltic countries (Raty & Snellman, 1997), Australia (Schebeci & Sorensen, 1983; Scholes & Stahl, 2020), Middle East (Buldu, 2006; İvgin et al., 2020; Rubin et al., 2003) and so on. When all these studies are examined, we may say that stereotyped characters related to science and scientists have emerged, regardless of country, language, religion, and race. To many results stereotype characters increase with age (Chambers, 1983; Song & Kim, 1999), and students drew more male scientists than female scientists (Barman, 1999; Bernard & Dudek, 2017; Chambers, 1983; Kabataş et al., 2020; Özsoy & Ahi, 2014; Quílez-Cervero et al., 2021), and describe commonly known scientists such as Einstein, Newton (Akçay, 2011; Jones & Hite, 2020), etc. In addition, one of the results supported by the international literature is that the students with good socio-economic status can give more details than the weak ones. Many researchers explain this and similar situations as the effect of the media and students' perceptions of scientists are strongly influenced by it. However, in many studies, it is possible to see that different factors can play a role. So, we may say children are not only affected by the media, but also by the environment they live in, social life, and events. For example, Rubin et al., (2003) stated in their study where takes place in Israel most Arabic-speaking students drew Classical Islamic scientists and described the scientist as an Arab male, while Hebrew-speaking students painted a typical Western man. Another example can be given from a study conducted in Fiji. Sharma and Honan (2020) stated that because Fiji is a colonial country, the education system still continues to spread the western view of science, so white scientists are drawn more. To Sharma and Honan (2020) pre-service teachers cannot describe themselves as scientists because they are not given the opportunity to see scientists who look like them. Here and similar studies show that the reasons related to the state of geography may be dominant also.

To results of the studies also presents the state of how students place “science” in society. In some studies, students use symbols of privacy and danger that are among the characteristics of many studies such as "stop," "do not approach", “secret” etc. Chambers (1983) states in his study that secret military and industrial research conducted at universities in the United States creates a completely different science perception in the minds of children. In recent years we believe pandemics, artificial intelligence, bio technologic implications, and space studies have definitely changed students' perspectives on scientists and science career plans. For instance, Cervero et al. (2021) state that the COVID-19 Pandemic has modified students’ vision about the construction of science, the person who is dedicated to science and the concept of research in which it is carried out, as well as the processes developed for scientific research.

According to the common results in the literature, other factors for drawing stereotyped characters can be listed as curricula, and textbooks, that convey a more positivist understanding of science to students. There have been radical changes in Turkey since 2005. With the inclusion of the "constructivist" approach in the education system, the view of science and scientists is more associated with daily life. We can describe it as a period in which the post-positivist view outweighs the prominence of raising scientifically literate individuals. Then, it can be stated that the approaches to science and scientific processes, together with the "science-technology-society-environment" theme included in the program in 2013, created awareness in both students and teachers. The emphasis on careers in science can also be stated as the most important innovation of this period. With the inclusion of STEM understanding in the science curricula in 2017, we can say that both the research and inquiry strategy were accepted, and the scientific processes were tried to be built to solve the problems of the future world.

The purpose of our study is to systematically investigate studies in which perceptions about Scientists in Turkey are measured based on drawings. The fact that Turkey is the center of the

Middle East and Europe and has an essential role as a bridge where makes us think that has affected many features of both Europe and the Middle East. In this context, we think that the studies conducted in Turkey will shed light on these two regions and that this systematic review study will contribute to the literature to reveal the scientific perspectives of the students in the curriculum-based changes and will provide reliable evidence for recommendations to schools, teachers and curriculum developers.

## 2. Method

A systematic review is a research paper that uses systematic and clearly defined methods to present, categorize, analyze and report aggregated evidence on a particular topic, and rather presents a synthesis of previous research (Tutar & Erdem, 2020, p:410). To conduct this review, we followed the guideline of the PRISMA (Liberati et al., 2009) document including the five main activities: (1) study description, (2) development of search strategy; (3) selection of relevant studies; (4) evaluation for evidence quality extraction, (5) synthesis and analysis of data from the included studies. The research process can be seen in Figure 1.

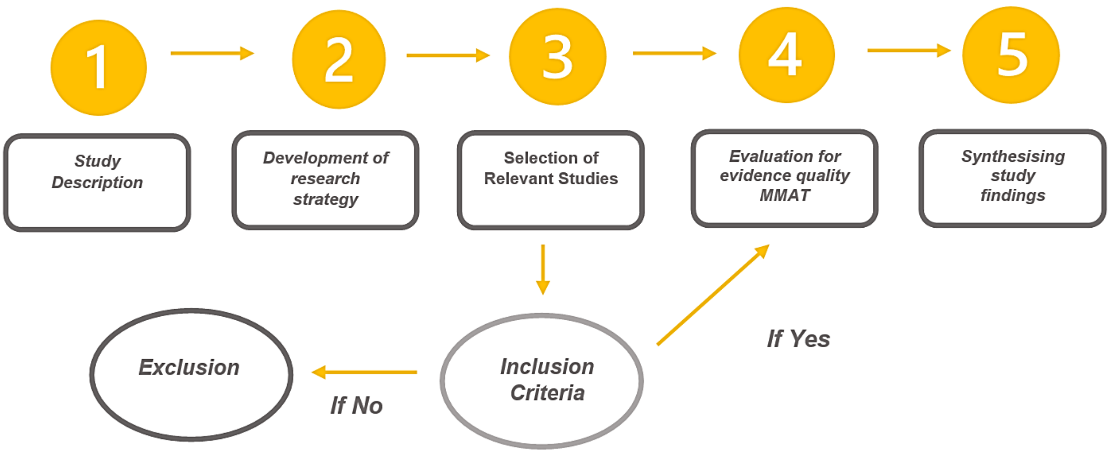



Figure 1. *Systematic Review Prosses*

### 2.1. Study Description

Our search process began with creating research question and sub-problems.

"How is the profile of scientists drawn by pre-school, primary, and secondary school students in Turkey?"

a) What are the research aims, methodologies, outcomes, and suggestions of the studies?

b) What are the trends in the publication date, database, regional distribution, designs and methods, data collection tools, class-level distribution, sample sizes, and study durations of the studies?

Ethics committee approval was obtained for the research from Ordu University with the decision numbered 2022/74 from the meeting numbered 6 on 28.04.2022.

### 2.2 Development of Search Strategy

A research strategy was developed to reach all possible related studies. We identified three steps in the process: identification of search terms, formulation of search terms, and selection of databases (Liberati et al., 2009).

### 2.2.1. Identification And Formulation of Search Terms

Within the scope of our research purpose, we identified search terms. Before generating search formulas related literature was reviewed briefly (Angın & Özenoğlu, 2019; Çavaş et al., 2020; Deniş & Erduran, 2015; Erdoğan, 2018; Kaya et al., 2008; Leblebicioğlu et al., 2011; Türkmen, 2008). After the literature review, we decided on the search terms as shown in Figure 2. The strings were modified for different online databases as per requirement while keeping the logical order consistent.

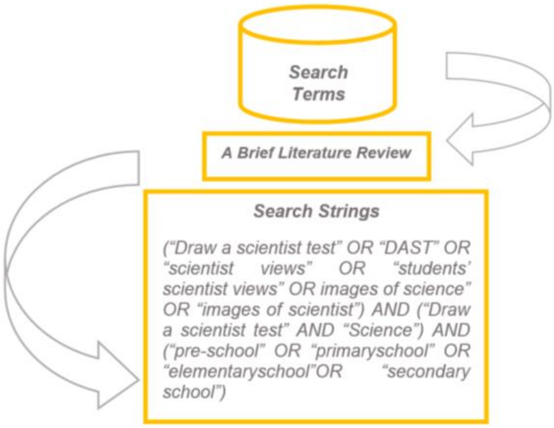



Figure 2. *Search Terms and Search Strings*

### 2.2.2. Selection of Databases and Studies

In this review *Web of Science, Scopus, ERIC, TR Dizin, and EBSCOHOST* databases were used as initial resources. We focused on these databases because the studies in the Turkish literature are included mostly in these databases.

### 2.2.3. Selection of Relevant Studies

We determined 6 inclusion and 3 exclusion criteria for the review to access the relevant studies.

*The inclusion criteria involved in this study are:*

a) The articles that were carried out in Turkey regardless of the language difference,
b) Studies that used the Draw a Scientist Test and other types of DAST (m-DAST, DAST-C, etc.)
c) The studies were carried out at pre-school, primary, and secondary school levels.
d) The studies were carried out within the scope of science education.
e) Qualitative, quantitative, and mixed method studies that used DAST (and other types of DAST) as a data collection tool,

f) Articles were published between 2006 and 2021.

*Exclusion criteria are:*

a) Theses, proceedings, and abstracts related to the subject were not included in the study.
b) Studies have been written using DAST but not using DAST test
c) Studies that did not differentiate as means of samples between high school and primary education levels were not included. General information for selecting the paper can be seen in Figure 3.

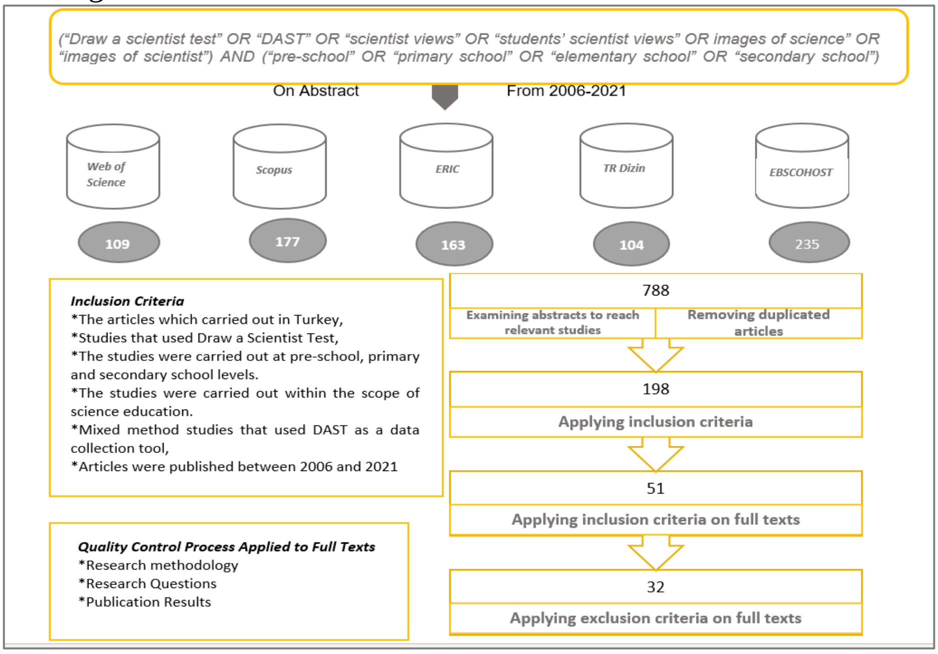



Figure 3. *Study Selection Process*

### 2.3. Quality Control Process

In this study, the MMAT tool (2018) developed by Hong et al. was used as the Critical Appraisal Tool which is included in Appendix 1. At the same time, studies that examined with MMAT by three researchers were also examined by the fourth researcher in the study group, and an agreement was reached.

#### 2.3.1. Research Methodology

In this section, the papers were discarded from the review if their design and analysis were not provided sufficient details. Studies were scrutinized to ensure that all of them have the essential information on research objectives, design or methodology, participants' demographics, DAST intervention, analysis, and results.

#### 2.3.2. MMAT Tool For Critical Appraisal Checklist

This critical appraisal tool is designed for the appraisal stage of systematic mixed studies reviews, and it permits to appraise the methodological quality of five categories of studies: qualitative research, randomized controlled trials, non-randomized studies, quantitative descriptive studies, and mixed methods studies (Hong et al., 2018).

#### 2.3.3. Data Synthesis and Analyzing

In this section, we organized the data obtained from the studies with Dedoose 9.0.15 version which is a cross-platform application for analyzing qualitative and mixed methods research with text, photos, audio, video, spreadsheet data, and an ID description table (Appendix 2). The Dedoose process is explained in Table 1 for quantitative and qualitative data.

Table 1. *Dedoose process for quantitative and qualitative data*

| Papers | Quantitative Data | Qualitative Data |
|---|---|---|
| S1-S32 | 1. For quantitative data, we defined demographic attributes to organize each article's<br>**Database,*<br>**Publication Year,*<br>**Name of the study,*<br>**Type of study,*<br>**Journal in which it was published,*<br>**Subject area,*<br>**Place of study,*<br>**Duration of the study,*<br>**Design of the study,*<br>**Method of the study,*<br>**Data collection tool,*<br>**Sample size,*<br>**Data analysis method,*<br>*Grade-level information in which the study was conducted was recorded.<br>2. Frequency analysis for demographic attributes<br>3. Revealing the relationship between demographic data and qualitative data | The table just shows the main codes, but subcodes are not shown here.<br>**Research Symbols*<br>**Knowledge Symbols*<br>**Alternative Research Symbols*<br>**Scientist General Appearance*<br>**Scientist Appearance Picture*<br>**Scientist Characteristic*<br>**Scientist Names*<br>**What the scientist does*<br>**Before and After Intervention*<br>**Physical resources*<br>**Relevant Captions*<br>**Technology*<br>**Working Area*<br>**Work Environment Features*<br>**Field of study*<br>**Study Purpose*<br>**Study Results*<br>**Study Suggestions*<br>**Mythical stereotypes*<br>**Danger Symbols*<br>**Secrecy Symbols* |

### 2.4. Limitation of the Study

Despite careful reviewing of the literature and ensuring the accuracy and reliability of the data to carry out this study, there may be studies that could not be accessed due to electronic sources or limited accessibility of the study itself. In addition, this study is limited to the papers published until May 2, 2021.

Also, the timeline of the study can be seen in Table 3.

Table 2. *Timeline of the study*

| DATE | Phases of Systematic Review |
|---|---|
| 01.03-11.04.2021 | Performing the systematic compilation phase (forming the study question, identifying keywords for examining databases, establishing exclusion and inclusion criteria, etc.) |
| 12.04.-25.04.2021 | Accessing the studies in the database and deciding on the studies to be examined according to the selected criteria |
| 11.04-18.04.2021 | Creation of the paper description table where various features of the studies will be recorded |
| 19.04- 26.04.2021 | Determining the Critical Appraisal Tool (MMAT) and examining the studies within this framework |
| 27.04-29.05.2021 | Examining the MMAT and description table information (3 researchers and 4 papers for each) recorded by each researcher by another researcher and determining the agreement |
| 03.06-31.06.2021 | Entering qualitative and quantitative data into the Dedoose program and analyzing. |
| 30.07-30.08.2021 | Study reporting |

## 3. Findings

In this section, we presented the synthesized and analyzed findings.

### 3.1. Frequency Analyses of The Study Attributes

#### 3.1.1. Publication Year

Studies involved in the systematic review are published between 2006-2021. As seen in Figure 4 no study has been carried on in 2006 and 2007 and more studies have been conducted on the subject since 2011 and 2013.

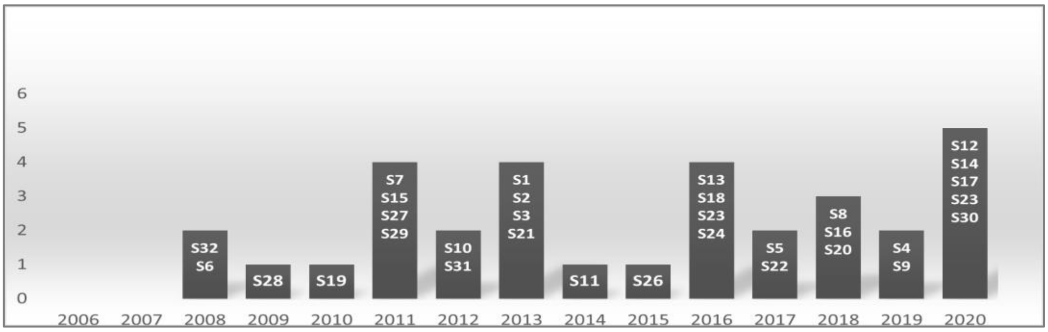



Figure 4. *Number of publications per year between 2006-2021*

#### 3.1.2. Databases

Studies included in the research are mostly published in ERIC and TR DİZİN databases (Figure 5).

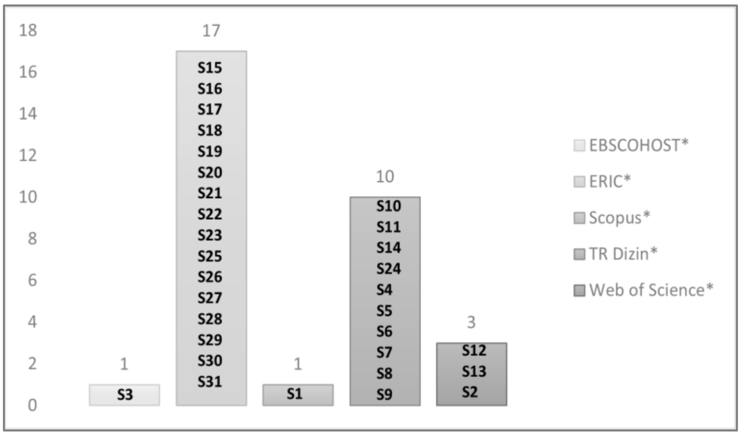



Figure 5. *Distribution of studies according to databases*

### 3.1.3. Research Designs and Methods

The studies included in our research show that various methods and techniques are used in both qualitative and quantitative designs. Figure 6 shows the most preferred designs of the included studies 37,5% qualitative and 34,4% quantitative design.

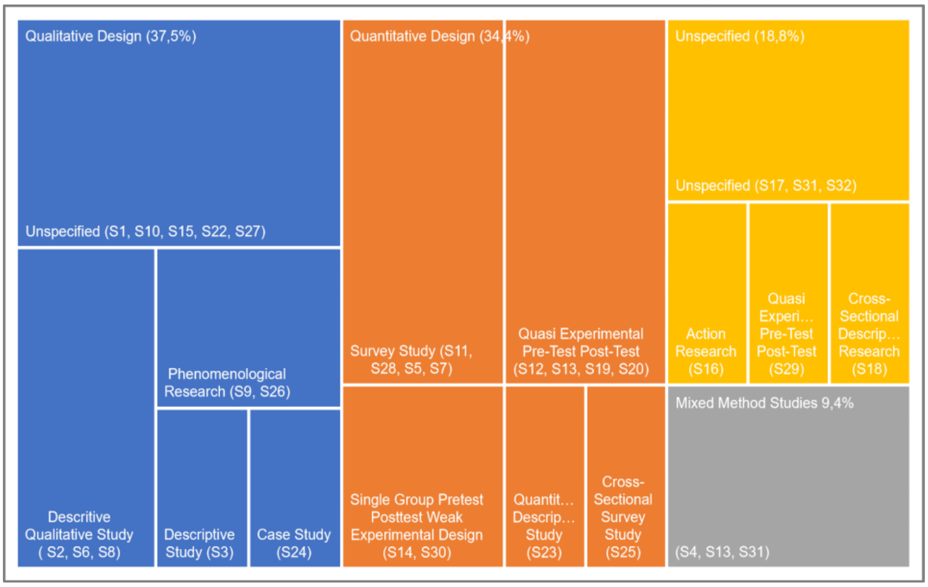



Figure 6. *Research designs and methods of studies*

### 3.1.4. Data Collection Tools

50% of the included studies preferred to collect the findings with two data collection tools together with "DAST". However, in many studies, students' views of the scientist are tried to be obtained only by using DAST or m-DAST (40,7%) (Figure 7).

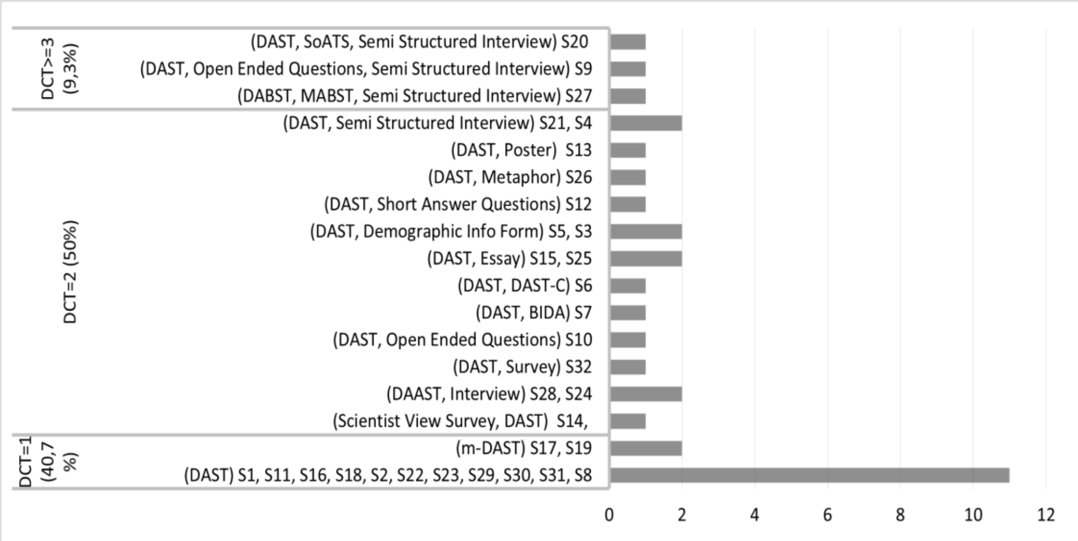
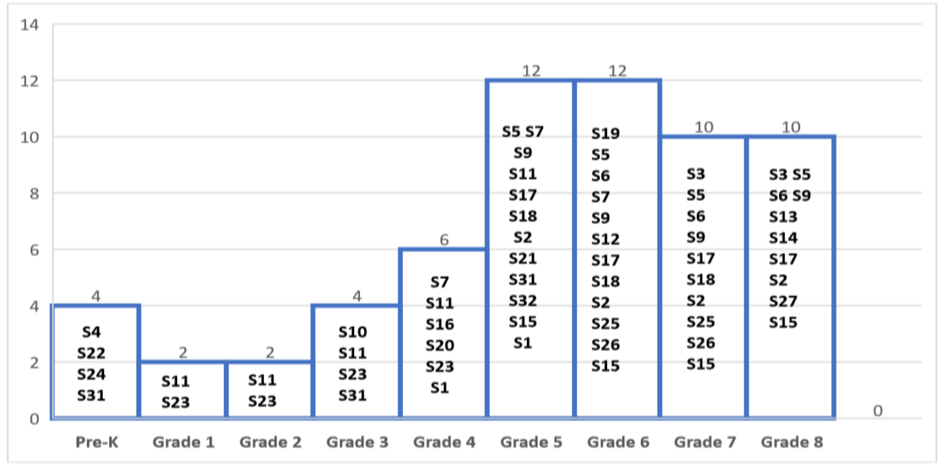



Figure 7. *Data collection tools included studies*

### 3.1.5. Distribution of Grade Level

We may see that the least studied grade level is the 1st and 2nd grades, followed by the preschool and 3rd grades. Most of the studies were conducted between the 5th and 8th grades (Figure 8).




**Most of the studies contain more than one grade level.*

Figure 8. *Distribution of the studies by grade level.*

### 3.1.6. Sample Sizes of The Participants and Study Duration

Most of the studies' samples had less than 50 students and generally took less than 1 month (most of them in 1-2 lesson hours) in terms of research duration. Surprisingly, there is no study duration of more than <u>between 3 months -1 year</u> and <u>more than 1 year</u> (Figure 9).

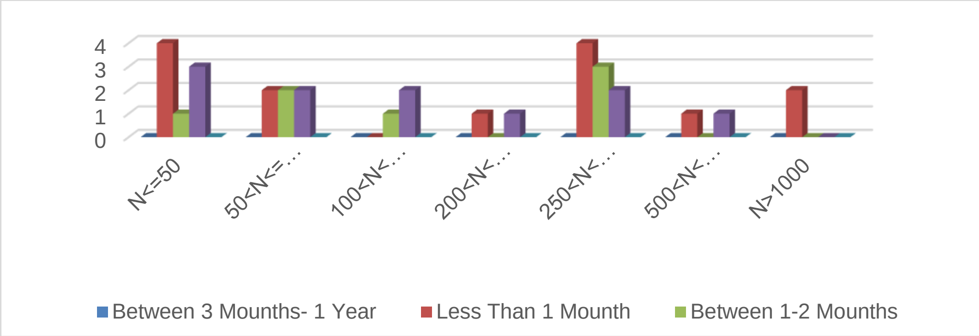



Figure 9. *Study duration and sample sizes of the studies*

Regardless of sample size, majority of studies have one or two hours application. In those studies, researchers met the students in classrooms and asked them to draw a picture immediately with no intervention. Studies with long duration have certain educational settings and implementation.

### 3.2. Content Analyzes of The Studies

#### 3.2.1. Map of the Results of The Studies Conducted in Turkey

In this section, we tried to code the studies' findings and results into 15 codes and 105 subcodes. Codes and subcodes are presented in Table 3.

Table 3. *Codes and subcodes used in the study*

| **Codes** | **Sub Codes** | **f** |
|---|---|---|
| Alternative Research Symbols | Virus, Scales, Dinosaur, Solar Panel, Patient/Vaccination, Oxygen Cylinder, Watch, Bones, Fire Extinguisher, Atom, Elevator/Generator, Speech/Thought Bubbles, Stethoscope, Award | 17 |
| Characteristics Of Scientist | Person Who Has a Social Life, Reckless Person, Working Alone, Team worker, Independent, Hardworking, Originator, Smiling Person, Curious, Intelligent | 10 |
| General Appearance of the Scientist | ***Head Region** Mustache, Messy Hair, Spiked Hair, Bald Hair, Well Kept Hair, Beard, Long Hair | 7 |
| | ***Gender** Female, Male, Female-Male, Undefined | 4 |
| | ***Scientist Age** Young, Middle Age, Elderly Scientist | 3 |
| | ***Face Expression** Crazy, Happy, Angry or Unhappy, Worried | 5 |
| | ***Accessories** Necklace, Hat, Glasses | 3 |
| | ***Outer Wear** Lab Coat, Casual Cloth, Astronaut Cloth, Tie-Bow Tie-Scarf | 4 |
| Knowledge Symbols | File Cabinet-Bookcase, Book, Formula, Graphical-Mathematical Expression | 4 |
| Research Symbols | Test Tubes, Planet, Magnifying Glass, Plants, Test Animals, Fossil, Microscope, Dry İce, Gravity, Electric Cables, X-Ray | 11 |
| Relevant Captions | Eureka, Light Bulb, Formulas | 3 |

| | | |
|---|---|---|
| Results | Media Affect, Science Field, Grade Level, Effect to Gender, Role of Culture, Albert Einstein, Teacher, Family, Results for Gifted Students, Meeting Scientist, Technology Usage in Science Courses, "Science" "Man", Social Life, Course Stuff, Implementations | 15 |
| MDSS | Mythical Stereotypes, Secrecy Symbols, Danger Symbols | 3 |
| Technology | Computer, Aircraft, Time Machine, Machine, Television, Phone-Cell Phone, Spacecraft, Telescope, Robot, Car | 10 |
| Working Place | **Outdoor**<br>Work in nature, working in space, working under the sea, working underground, | 4 |
| | **Indoor**<br>Laboratory, observatory, science center, home, class/school, office | 6 |
| | **Both Indoor and Outdoor** | 1 |
| | **Undefined** | 1 |
| Study Foci | Investigating students' scientist view, investigating the source of the students' scientist view, the effect of the intervention on the students' scientist view (revising the stereotypical scientist view), examining students' scientist view in terms of variables | 4 |
| Working Environment Materials | Desk, calculator, pen/ pencil, panel / board | 4 |
| Study Field | Engineering, Physics, Chemistry, Biology, Astronomy, Medicine, Mathematics | 5 |
| Suggestions | Teacher, Classroom Activities, Future Research Suggestions, Media, Textbooks, Scientist, Curriculum, Gifted Students | 8 |

### 3.2.2. Foci of the Studies

Foci analysis of the studies were presented in Table 4.

Table 4. *Foci of the studies*

| **Foci of the Studies Code** | **Sub Code** | **f** | **Study Id** |
|---|---|---|---|
| A) Investigating students' scientist view | • Stereotypical Images<br>• Alternative Images<br>• Additional Images | **14** | S32, S31, S26, S24, S11, S10, S7, S2, S1, S23, S22, S17, S15, S25 |
| B) Investigating the source of the students' scientist view | N/A | **1** | S32 |
| C) The effect of the intervention on the students' scientist view (revising the stereotypical scientist view) | • Lego Mindstorms EV3 | **12** | S30 |
| | • Science Camp | | S29, S12 |
| | • Science and Scientist Stories | | S27, S21, S16 |
| | • Inquiry-Based Science Activities in Nature | | S14 |
| | • Poster | | |
| | • Scientist Biography | | S13 |
| | • Context-Based Learning Activities | | S21 |
| | • EIL | | S19 |
| | • Direct Reflective Approach | | S16 |
| | • Gender | | S28, S9, S5, S3, S17 |

| | | | |
|---|---|---|---|
| D) Examining students' scientist views in terms of variables | • Nationality | | S8 |
| | • Grade Level | **1** | S6, S5, S3 |
| | • STEM concepts | **1** | S4 |
| | • Cultural Similarity | | S28 |

For easier understanding of the subjects, we found it appropriate to display data on mind maps prepared on CANVA which is a graphic design platform that allows users to create social media graphics, presentations, posters, and other visual content. Related displays are in Figures 10-20.

### 3.2.3. Alternative Research Symbols

There are several alternative research symbols such as a watch, award, etc. (Figure 9).


Figure 10. *Alternative research symbols for included studies*

### 3.2.4. Characteristics of the Scientist

Students depict scientists as people who work alone, are hardworking and are curious mostly (Figure 11).

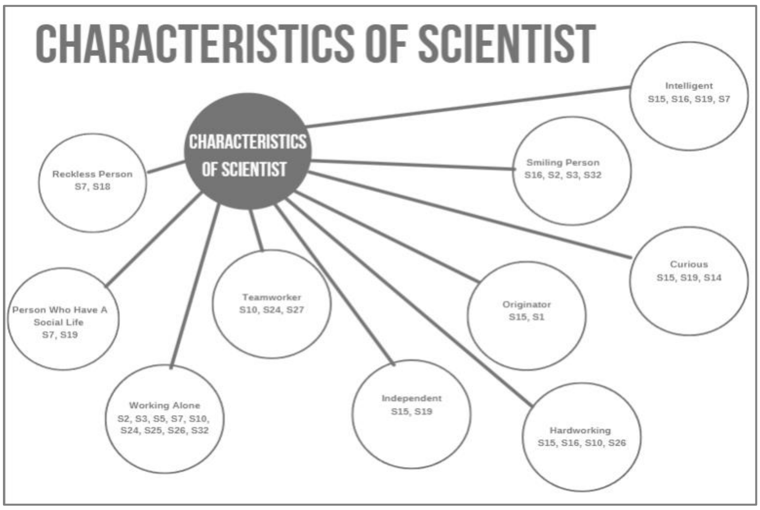



Figure 11. *Characteristics of the scientists listed in studies*

### 3.2.5. General Appearance of Scientist

The general appearance of a scientist has six main indicators such as "head region, gender, scientist's age, face expression, accessories, outerwear" (see Figures 12-13).

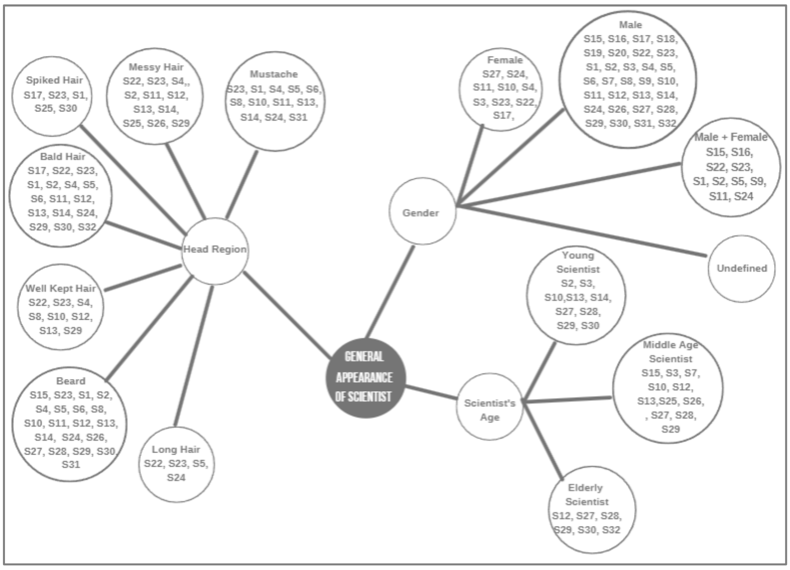



Figure 12. *The general appearance of the scientist.*

For the head region, students preferred to depict the scientist with bald hair or messy hair, mustache, and beard. For gender indicator, most of the students preferred to depict scientists as male. For scientists' age, most of the papers reported that students preferred to draw young and middle-aged scientists. For facial expressions, students expressed their scientists as happy, and then they preferred the angry and unhappy expressions. Most of the students depicted scientists wearing glasses and for outerwear, studies reported that students drew scientists with lab coat in all studies.

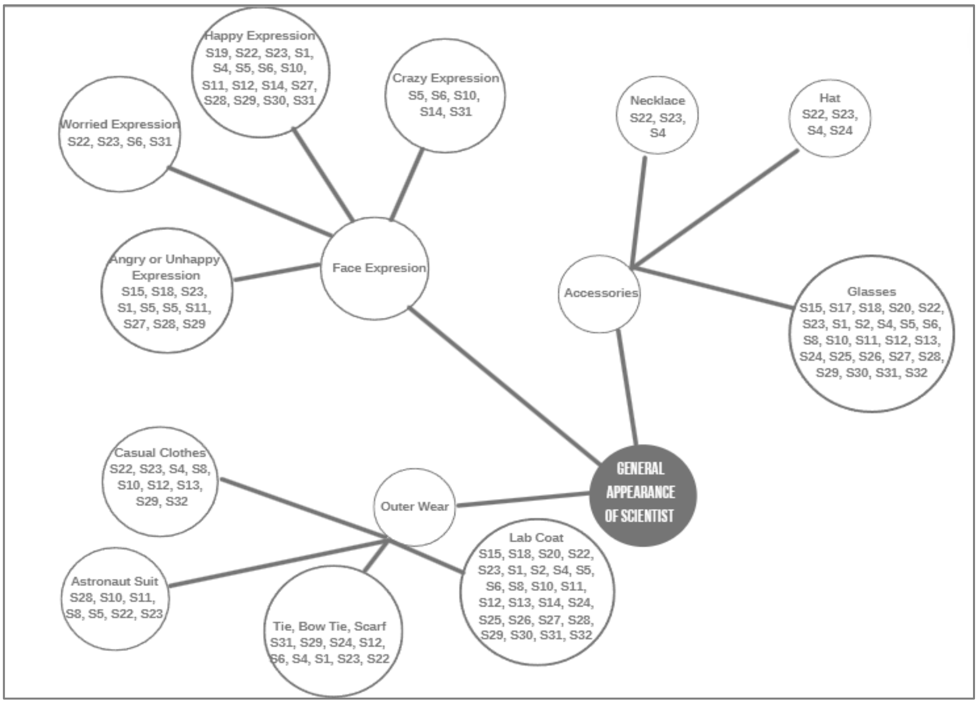


Figure 13. *The general appearance of scientist*

### 3.2.6. Knowledge Symbols

Students drew formulas, book cabinets, books, and graphical and mathematical expressions as symbols of knowledge while describing scientists in their working environments (Figure 14).

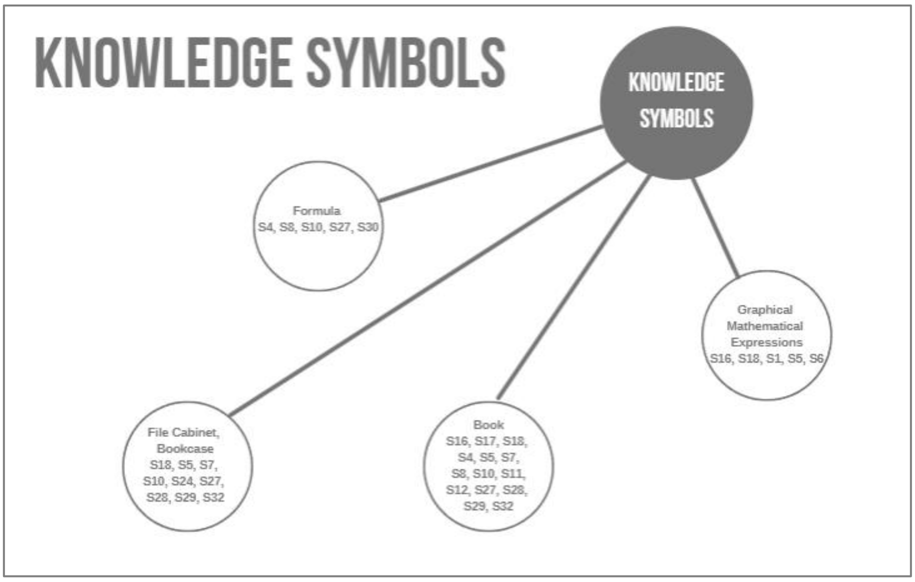



Figure 14. *Knowledge symbols*

### 3.2.7. Research Symbols

Students mostly focused on laboratory materials such as test tubes, magnifying glasses, microscopes, and test animals or test plants (Figure 15).

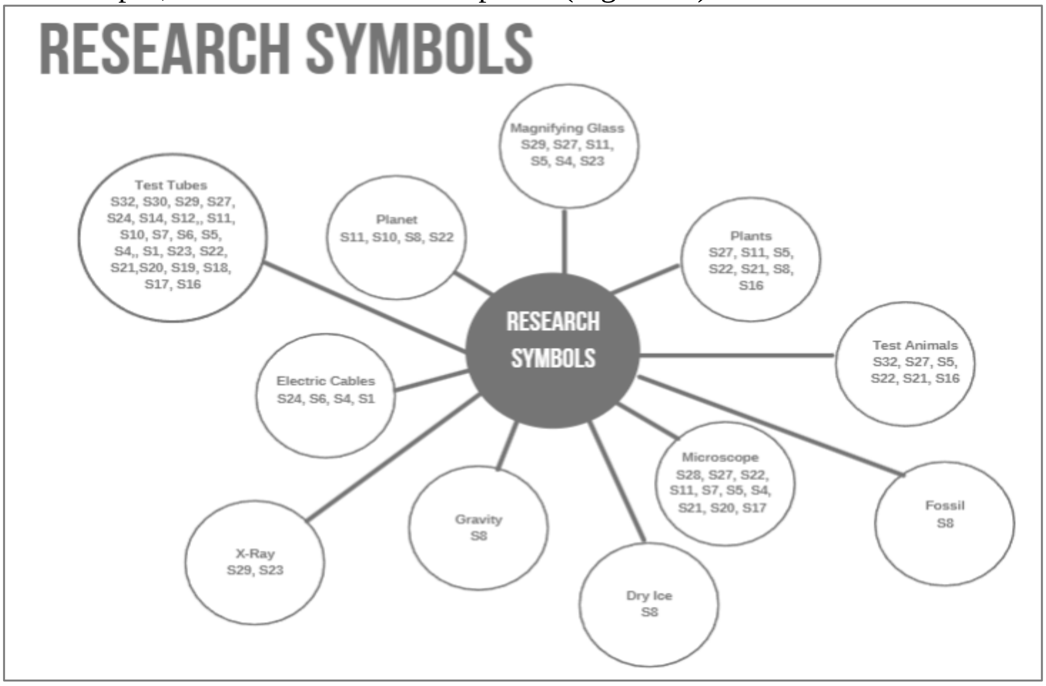


Figure 15. *Research symbols*

### 3.2.8. Relevant Captions

3 indicators were determined such as "Eureka, Light bulbs, and Formulas" similar to international studies (Figure 16).

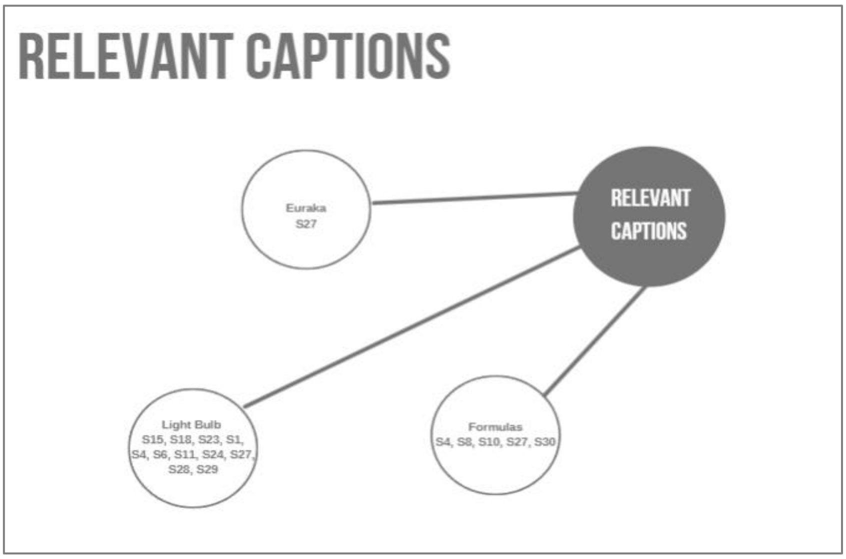



Figure 16. *Relevant captions*

### 3.2.9. Technology Symbols

Students associate technology with computers, telescopes, etc.

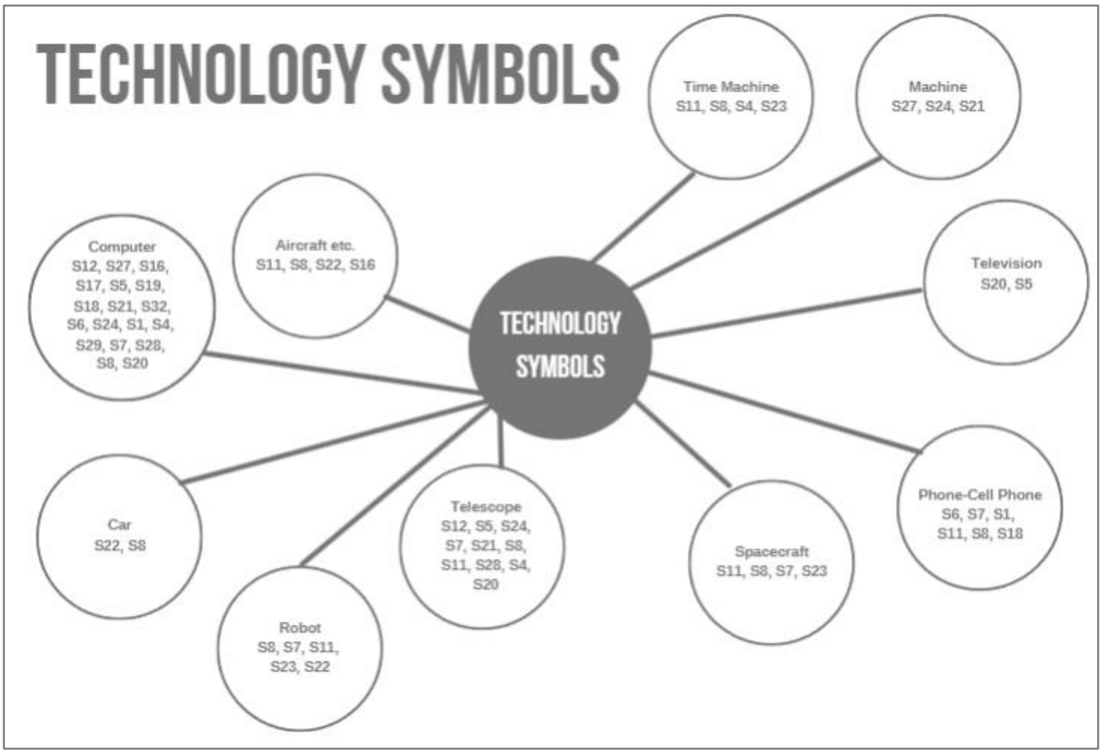



Figure 17. *Technology symbols*

### 3.2.10. Working Place

One of the important indicators is working place. There are 4 main codes on this subject. Students preferred to draw scientists indoors, especially in the laboratory.

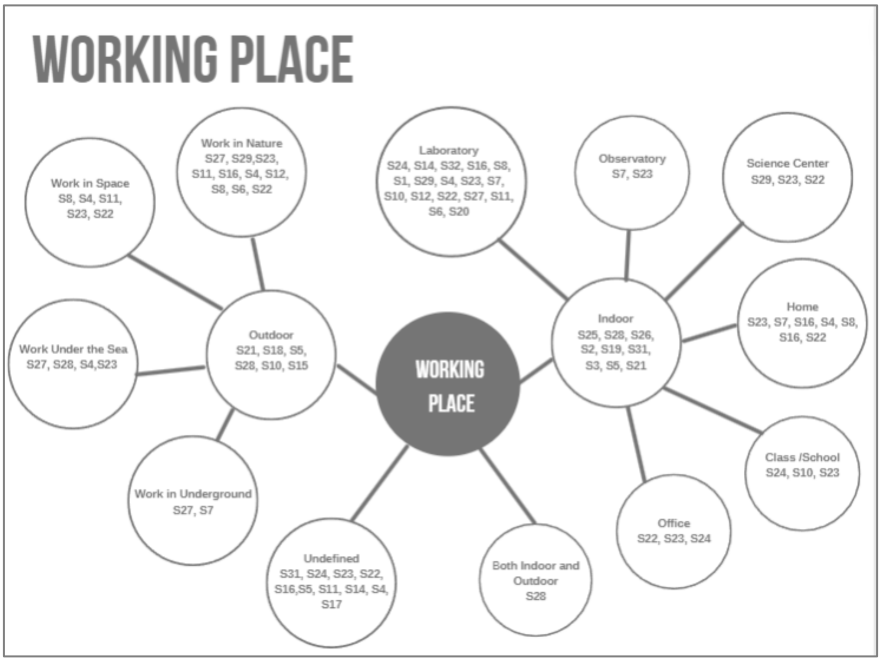



Figure 18. *Working place*

### 3.2.11. Working Environment Materials

Students used some materials such as desks, panels/boards, pens/pencils, and calculators to describe scientists while they are in their working environment (Figure 19).

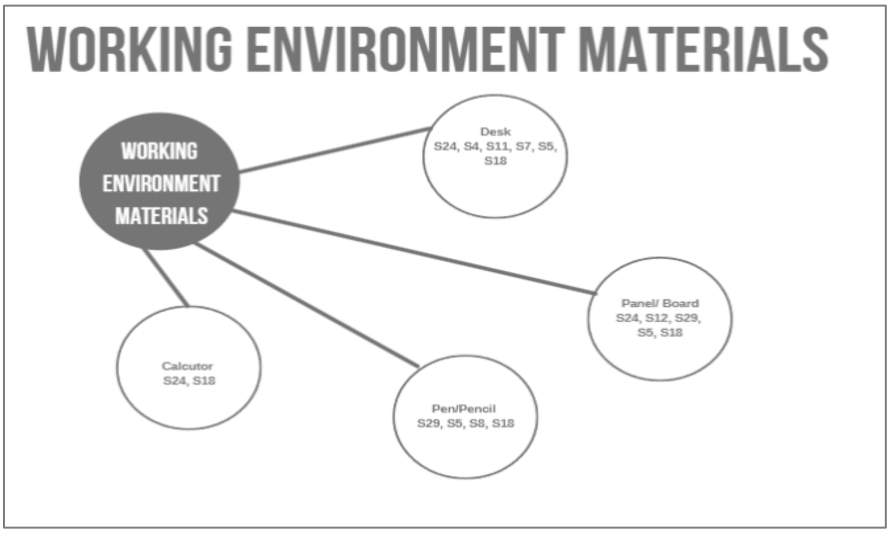



Figure 19. *Working environment materials*

### 3.2.12. Study Field

Students generally drew scientists while working in the fields of chemistry and physics (Figure 20).

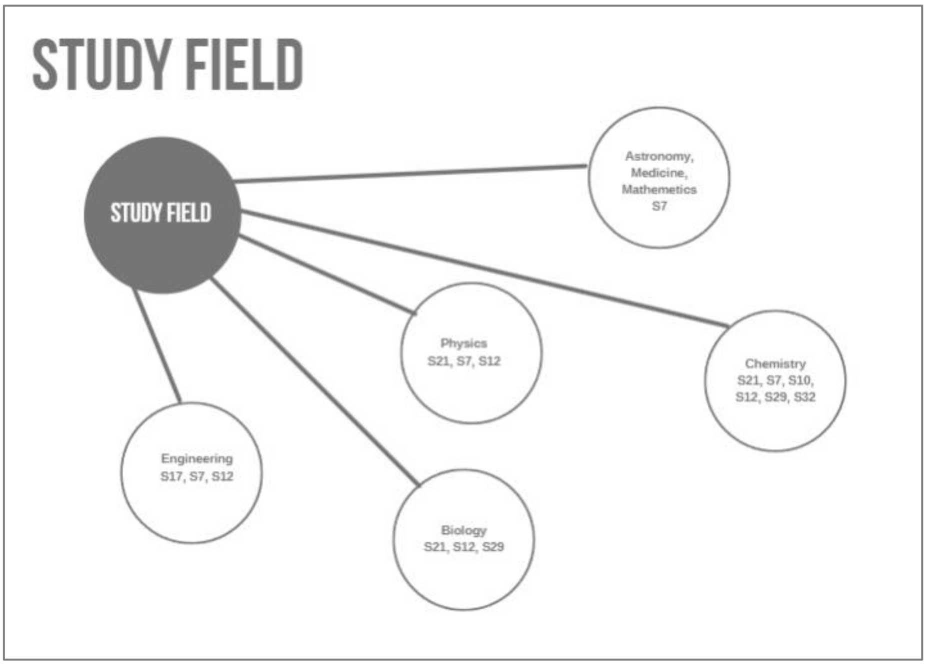



Figure 20. *Study field*

### 3.2.13. Results of the Papers

There are several findings about the reasons for the stereotypical image of the scientist (Table 5).

Table 5. *Results presented in the papers*

| Variables | Explanations |
|---|---|
| *Media Effect* | Cartoons, Popular Movie Characters, social media. |
| *Role Of Culture* | It is generally stated that the factors mentioned in this subject are family, friends, teachers, and media (social, written, and printed media). |
| *Effect to Gender* | Results showed that male students draw male scientists but female students draw female scientists to react the place of women in society and to show themselves as a scientist in the future. |
| *Science Domain* | It was reported in the studies that students drew mostly scientists in the fields of chemistry and physics in their drawings. |
| *Grade Level* | Researchers extrapolated that as the grade level increases, the stereotype image of scientists increases |

| | |
|---|---|
| *Albert Einstein* | According to the results of many studies, it is stated that Albert Einstein's perception of the scientist in a white coat, messy hair, and working in the laboratory is caused by Albert Einstein and this is supported by the media |
| *Teacher* | In many studies, it is stated that teachers' perceptions and speeches about science and scientist so positivist. |
| *Family* | Some of the studies reported that family is another factor in the emergence of the female scientist view. According to interviews results, some girls would not prefer science even though they wanted it because of the place of women in society |
| *Meeting the Scientist* | Some research results show that the vast majority of students haven't met any scientists. |
| *Technology Usage in Science Courses* | It is stated that most of the students' drawings are made for technology, and it is seen that this situation is associated with the use of technological materials in science classes more than before. |
| *"Science" "Man"* | Studies reported that the statement "Bilim adamı" "Science" and "Man" in the Turkish language caused the misconception that science is action specific to men. |
| *Course Stuff* | Almost all studies reported that textbooks are insufficient to represent the scientist's image. |
| *Social Life* | Almost in all studies results, it's mentioned to introduce scientists as social and they all have a social life |
| *Implementations* | Experimental studies results show that the majority of approaches, methods, and techniques achieved change the perception of the stereotypical image of the scientist. |
| *Results for Gifted Students* | Papers studied with Gifted students reported that gifted students affected by media as the other students. Also, the science careers of gifted girls are negatively affected by the image of scientists in society. they draw the scientists from their own culture negatively and they want to get to know more about them. |

### 3.2.14. Suggestions of the Papers

We also put forward the suggestions made on the subject under eight major topics such as teachers, classroom activities, future research suggestions, media, curriculum, textbooks, scientists, and gifted students (Table 6).

Table 6. *Suggestions presented in papers*

| Variables | Explanations |
|---|---|
| *Media* | Scientist characters in films, cartoons, pc games, etc. should be designed more carefully and documentaries about science and scientists should be shot. |
| *Curriculum* | Curriculum creators should be wary of female scientists, while explaining all the subjects in the curriculum, examples from Turkish scientists related to the subject should be given and introduced, number of internet sites that introduces Turkish scientists should be increased. |
| *Teachers* | It is stated that teachers should avoid sexist language, encourage students to develop their own theories, use a variety of methods and techniques (from kinder garden to high school), know how to change the stereotypical image of the students, and inform their students about robotics, coding, space exploration, and social sciences. |
| *Textbooks* | Female scientists should be placed in textbooks, pictures, and stories of scientists reflecting the post-positivist science view should be added to the textbooks, and the contribution of the Turk-Islam civilization to science should be added in textbooks. |
| *Classroom Activities* | Scientists should be invited to the classes (especially from the field of social sciences and women scientists) or visits should be arranged to the workplaces of the scientists, and the news of the scientists (both men and women) should be shared with the whole class, well-structured activities should be designed (historical and scientific stories, concept cartoons, pictures, videos, animations, etc.), a unit design should be done on the subject, context-based learning and argumentation applications are recommended, out of class activities should be designed, conferences and meetings with scientists should be arranged, researchers and teachers should organize science camps, |
| *Scientists* | It is stated that it is a social responsibility for scientists to meet with students and tell them about their profession. |
| *Gifted Students* | There should have interviews with gifted students to gather deeper information on the subject. Since many of them want to meet with scientists, it should be ensured that they come together with scientists. A different science curriculum should be created for such students. Scientists and the nature of science should be covered in detail and effectively. Universities' laboratories and research centers can be opened for such students and students should be supported to make projects and produce their own products, and they should be made to feel like scientists. |
| *Future Research Implications* | Studying with wider groups, investigating media influence further, designing a unit on the subject, conducting longitudinal research of how a particular student group's view changes according to grade level, examining the social dimension of the subject, using various data collection tools, conducting |

| | |
|---|---|
| | qualitative research, investigating the views on female scientists, doing more research in the range from kindergarten to 3rd grade. |

## 4. Results, Discussion, and Suggestions

In this chapter, results, discussion, and suggestions are presented in line with the findings.

We determined that most studies were carried out in 2020, and no studies were conducted in 2006 and 2007. It is noteworthy that the number of studies has increased since 2013. The reason for this is the inclusion of socio-scientific issues and science, technology, society, and environmental learning in the curriculum in 2013 (MEB, 2013) and special purposes to learn science-related professions to help students make career plans on this subject (MEB, 2018). With the inclusion of more scientific subjects in the curriculum, the awareness level of the students has increased, and this has also been reflected in the studies conducted in recent years. Although the number of studies increased after the program changes in Turkey, it can be said that the state of the students' views in these studies did not change much. The results of a study conducted in 1998 give us important clues in this regard. Although 5 years have passed after the change in the curriculum in England, it is seen that the students' perspectives on scientists have not changed much (Lynn & Douglas, 1998). Although the studies conducted in Turkey were carried out with the aim of "determining students' views on scientists, examining the effect of a teaching method or activity on students' views on scientists" and "examining students' views on scientists", we may say that it is necessary to carry out studies that examine the factors or eliminate these understandings.

The standard scientist image begins to form in the child's consciousness during the second and third years of education and it develops more in the 4th and 5th years. (Chambers, 1983; Schibeci & Sorenson, 1983). This perception of scientists, which will be formed at the end of primary school, will affect children's identification with science, their positive attitude towards science, and their planning for a career in science (Archer, DeWitt, Osborne, Dillon, Willis, & Wong, 2012). Thus, we can say that the perception of scientists that will be formed actually begins to develop at a very young age. However, according to the literature, the stereotypical scientist view has been developed since the pre-school period (Et & Kabataş Memiş, 2017). We may say that our students attend science classes with a certain perception of scientists, especially before the Science lesson starts (Küçük & Bağ, 2012). In our country, science lessons are given by classroom teachers starting from the 3rd grade. However, due to the multidisciplinary structure of basic education and the limited knowledge of classroom teachers in the field of science, it is seen that the science lesson is not attached enough importance in the first years of primary school (Bağ & Çalık, 2018). In this context, when the countries where science lessons are given from the first grade of primary school e.g Hong Kong, Korea, and Finland, and the success of these countries in international exams such as PISA are examined (Cerit Berber & Güzel, 2017), for our children to have a post-positivist perception of scientists, to have positive attitudes towards science and to make career plans in science-related professions, it is necessary to take precautions starting from preschool. Considering the studies carried out in Turkey, we recommend that related studies should be carried out in pre-school, 1st, 2nd, 3rd, and 4th grades since the studies are mostly concentrated between the 5th and 8th grades.

The data of the study offer essential clues about how Turkish students draw scientists into their minds. Students describing scientists as bearded and mustache, with messy or straight hair, bald or smooth, and long hair shows that they both have a stereotypical understanding and can break out of these patterns (McCarthy, 2015; Meyer et al., 2019). Other results that can support this situation are drawn the young or middle-aged scientists (Sharma & Honan, 2020), happy/unhappy or angry facial expressions (Akçay, 2011; Et & Kabataş Memiş, 2017), glasses, and white coat as accessories (Hayes, et al., 2020; Medina-Jerez, et al., 2020), and male scientists (Barman, 1999; Chambers, 1983; Kabataş et al., 2020; Özsoy & Ahi, 2014). Besides, the draw of daily clothes by students can be stated as gladsomely (Leblebicioğlu et. al., 2011).

When we look at the results of the study holistically, Turkish students use alternative symbols such as clocks, scales, speech bubbles, stethoscopes, and solar panels, they prefer to depict knowledge symbols with the library, book, formulas, and mathematical/graphical expressions, they describe scientists in the research environment who use experimental materials, microscope, magnifying glass, experimental animals or plants. Besides this computer is the symbol of technology, and the symbol of the light bulb is used as related captures like in many other studies (Buldu, 2006; Chambers, 1983; Mead & Metraux, 1957; Medina-Jerez, et. al., 2020; Sharma & Honan, 2020). Although Ferguson and Lezotte (2020) stated in their studies that symbols such as light bulbs should either be removed from DAST-C or should be defined in more detail, it is possible to say that in our study, the light bulb is a symbol that students use especially when describing the scientist. In addition, included studies show that students always drew scientists as people who usually use materials such as desks, panels/boards, pen/ pencils (İvgin et al., 2021), and calculators in an indoor laboratory environment (Fung, 2002) and generally work in the fields of chemistry and physics (Takach & Tobi, 2021). In addition, it has been determined that scientists are experimenting, inventing something, and conducting space and robot research. Studies reported that they do activities such as making bombs or preparing magic/potions. These are all consistent with studies reporting purely stereotypical results.

At a large rate male scientists were drawn in the studies (Barman et al., 1997; Emvalotis & Koutsianou, 2017; Erkorkmaz, 2009; Öztürk İrtem & Hastürk, 2021). In addition, we can say those female scientists were drawn by female students in most of the studies (Bernard & Dudek, 2017; Blagdanic et al., 2019; Özkan, 2016; Samaras et al., 2012). So many female students think that they could not be female scientists. There are different perspectives on this issue in the literature. Some researchers say that the socio-cultural structure imposes different roles for the two genders (Erdoğan, 2011) or that, as in the study of Brotman and Moore (2007), the equality and access opportunities of female students are not the same, there is male-oriented pedagogy in the curriculum, having minor importance to the nature and the culture of science and not associating the scientific identity with female students are listed. While we agree with all these dimensions, we think that the most important factors are the media and textbooks. Since the revolutionary developments of social life over the years have greatly affected education systems, it can be said that the mass media has taken the place of most of these factors, especially when the results of the studies examined. The fact that there are mostly male scientists in the textbooks distributed to the students by the Ministry of National Education and the discourse of the scientist creates this image in the students. The fact that more female scientists are included in the textbooks and that teachers pay attention to the language of expression while creating the perception of scientists will create a change in this perception. It is seen that girls need more encouragement in this regard (Bayrı et al., 2016) not only by the education system but also by their families and society. To create positive attitudes towards female scientists, inspirational examples should take part more in textbooks and mass media.

For instance, well-known female scientist Marie Curie's studies could be demonstrated as revolutionary changes in science. Also, Turkish female scientist Ozlem Tureci, who has generated one of the most efficient vaccine against Covid-19, should be presented as a role model. Those examples enable children to recognize that scientific works do not belong to male scientists and any individual can do science.

Children's perceptions of scientists give us strong evidence on their understanding of nature of science. In childhood, construction of scientific knowledge correlates with their perception of scientists (Hansson et. Al., 2021). As the findings indicate that most children have very alike stereotypical images in their minds which determine their perceptions. They should be encouraged to think differently to catch of nature of science. Here science education steps in to improve them to the desired level of thinking.

As highlighted in the previous section the perception of scientists in students includes very stereotypical elements. In studies conducted in Turkey, these stereotypical images formed in the image of scientists following the international literature are affected by media, culture, gender, teacher, family, technology use in science classes, course content, curriculum, textbooks, and social life. One of the results specific to our country can be given that the word "scientist" in Turkish carries male-oriented imagery (Kara & Akarsu, 2015; Özdemir, 2017; Özdemir & Ünal, 2020). In studies conducted with gifted students in Turkey, it is seen that gifted female students are negatively affected due to all these reasons, and although they want to be scientists, they do not dare to do so.

The researchers suggest that the cartoons, games, etc. in the media should be prepared more carefully, that documentaries promoting science and aimed at scientists should also be published, and that teachers should adopt a language that encourages male and female students and conveys both science and social sciences, On the other hand, it was stated that female scientists should be included in curricula and textbooks, scientists should be invited to schools or students should be seen in the working areas of scientists from different fields. For gifted students, it can be stated that the doors of universities should be opened and they should benefit from the opportunities of these educational institutions for their experiments or projects. In this way, they can be made to feel more like scientists.

For future researchers, an interdisciplinary approach that combines the different fields of study of the scientist should be made on the subject to create a post-positivist scientist perception, students' views on social sciences should be examined, and the views of female scientists should be investigated.

### 5.2 Ethical Text

"In this article, the journal writing rules, publication principles, research and publication ethics, and journal ethical rules were followed. The responsibility belongs to the authors for any violations that may arise regarding the article. " Within the scope of the research, ethics committee approval was obtained from the ethics committee of Ordu University with the decision dated 28.04.2021 and numbered 2022/74. There is no conflict of interest between the authors. The contribution rate of the first author to the article is 25%, the contribution rate of the second author to the article is 25%, the contribution rate of the third author to the article is 25%, and the contribution rate of the fourth author to the article is 25%.

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Yontar Toğrol, A. (2013). Turkish Students' Images of Scientists. *Journal of Baltic Science Education, 12*(3), 289-298.

# APPENDIX – 1

## MMAT TOOL for Critical Appraisal Tool

**Part I: Mixed Methods Appraisal Tool (MMAT), version 2018**

| Category of study designs | Methodological quality criteria | Responses | | | |
|---|---|---|---|---|---|
| | | Yes | No | Can't tell | Comment |
| Screening questions (for all types) | S1. Are there clear research questions? | | | | |
| | S2. Do the collected data allow to address the research questions? | | | | |
| | *Further appraisal may not be feasible or appropriate when the answer is 'No' or 'Can't tell' to one or both screening questions.* | | | | |
| 1. Qualitative | 1.1. Is the qualitative approach appropriate to answer the research question? | | | | |
| | 1.2. Are the qualitative data collection methods adequate to address the research question? | | | | |
| | 1.3. Are the findings adequately derived from the data? | | | | |
| | 1.4. Is the interpretation of results sufficiently substantiated by data? | | | | |
| | 1.5. Is there coherence between qualitative data sources, collection, analysis and interpretation? | | | | |
| 2. Quantitative randomized controlled trials | 2.1. Is randomization appropriately performed? | | | | |
| | 2.2. Are the groups comparable at baseline? | | | | |
| | 2.3. Are there complete outcome data? | | | | |
| | 2.4. Are outcome assessors blinded to the intervention provided? | | | | |
| | 2.5 Did the participants adhere to the assigned intervention? | | | | |
| 3. Quantitative non-randomized | 3.1. Are the participants representative of the target population? | | | | |
| | 3.2. Are measurements appropriate regarding both the outcome and intervention (or exposure)? | | | | |
| | 3.3. Are there complete outcome data? | | | | |
| | 3.4. Are the confounders accounted for in the design and analysis? | | | | |
| | 3.5. During the study period, is the intervention administered (or exposure occurred) as intended? | | | | |
| 4. Quantitative descriptive | 4.1. Is the sampling strategy relevant to address the research question? | | | | |
| | 4.2. Is the sample representative of the target population? | | | | |
| | 4.3. Are the measurements appropriate? | | | | |
| | 4.4. Is the risk of nonresponse bias low? | | | | |
| | 4.5. Is the statistical analysis appropriate to answer the research question? | | | | |
| 5. Mixed methods | 5.1. Is there an adequate rationale for using a mixed methods design to address the research question? | | | | |
| | 5.2. Are the different components of the study effectively integrated to answer the research question? | | | | |
| | 5.3. Are the outputs of the integration of qualitative and quantitative components adequately interpreted? | | | | |
| | 5.4. Are divergences and inconsistencies between quantitative and qualitative results adequately addressed? | | | | |
| | 5.5. Do the different components of the study adhere to the quality criteria of each tradition of the methods involved? | | | | |

# APPENDIX-2

## ID Table for Systematic Review

| | | |
|---|---|---|
| **Systematic Review ID Table** | Database | |
| | Author, Year | |
| | Name of Study | |
| | Type of Study | |
| | Journal Name | |
| | Sample | |
| | Field | |
| | Number of Sample | |
| | Place | |
| | Studying Time | |
| | Design/ Method | |
| | Problems/Sub Problems | |
| | Data Collection Tool | |
| | Sampling Method | |
| | Data Analyzing Method | |
| | Results | |
| | Suggestions | |

**APPENDIX-3**

**Studies Reviewed in The Systematic Review**

Akçay, B. (2011). Turkish elementary and secondary students' views about science and scientist. *In Asia-Pacific Forum on Science Learning and Teaching, 12*(1), 1-11). The Education University of Hong Kong, Department of Science and Environmental Studies.

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