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Greek Upper Primary Grade Students' Images About Science and Scientists: An Alternative Descriptive Piece of the Puzzle

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This study examined the perceptions of upper primary grade level students about science, scientists, and their work. Participants were 284 fifth- and sixth-grade students (aged 10–12) from six urban areas of Attica (Greece). An open-ended questionnaire was employed for data selection. Students' responses were analyzed both qualitatively (through thematic analysis) and quantitatively. The findings suggest that the participants in this study hold distinct perceptions of what science is, who a scientist is, and how science is done. Although most students referred to science and scientists in a positive light, our findings suggested that they held traditional and narrow perceptions of such issues (e.g., a scientist is a brilliant, talented person who works in natural sciences, science is a contributor to human welfare, or science is a product). Our data also suggested that the students could not make a clear distinction between science and technology, concepts that were used interchangeably in our study. Educational implications that may help breaking these naïve perceptions were discussed.

Keywords: perceptions about science, perceptions about scientists, science, primary school, students, stereotypes, Greece

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INTRODUCTION

Investigating Students' perceptions of science and scientists is an extremely fruitful field of research, and has long been of constant interest to scientists, researchers, and scholars. Knowing how students perceive science and scientists is considered important as these perceptions affect future academic and career choices (Garriott et al., 2017; Christidou et al., 2021). Many stakeholders have already expressed their concerns about the low participation rates of students studying science at the secondary/university level (Scholes and Stahl, 2020). Recent studies have also shown that the demographics of people working in STEM fields doesn't reflect inclusiveness and equality of access (Scott, 2018; Segarra et al., 2020; Shepherd et al., 2020; Cech and Waidzunas, 2021; Fry et al., 2021) and that there is a *"shortage of scientific personnel"* internationally (Meyer et al., 2019; Walls, 2022). With most countries recognizing the economic and social benefits of having scientifically engaged citizens, efforts to increase the number of individuals involved in science are a central issue in many state's central education policy (Shin et al., 2015; Chen, 2019).

In this context, students' perceptions about science and scientists are considered as a useful diagnostic tool that shows how they learn and think about science (Zimmerman and Bell, 2014), and a first step in capturing the views they have about *"who becomes a scientist," "who works in science," "what science is,"* etc. (Thomson et al., 2019). As research shows, boys and girls make decisions about science careers long before they graduate from college, so understanding early their views about science and their opinions of scientists is critical (Farland-Smith and Ledger, 2018). Furthermore, it is supported that if children do not form positive views about science and scientists throughout their primary school years, they are not likely to do so in secondary school and beyond (Smail, 1993; Grossman and Farland-Smith, 2021).

This paper examines these issues for primary school students enrolled in Greek schools. Based on our review, existing research in Greece is relatively limited and focuses on Students' drawings of scientists and their work, by using various versions of Draw-A-Scientist Test (DAST) (Chambers, 1983) tool (Christidou et al., 2012, 2021; Emvalotis and Koutsianou, 2018). Our approach, unlike the previous ones, adopted an open-ended questionnaire to gather data and a more qualitative data analysis framework for examining Students' responses. We believe that our results will expand the findings obtained in previous studies, providing a more comprehensive characterization of Students' views.

LITERATURE REVIEW

Students' Perceptions About Science

Although many studies have investigated perceptions about science of high school students (Songer and Linn, 1991; Griffiths and Barry, 1993; Griffiths and Barman, 1995; Tsai, 1998; Shi, 2021), college/university students (Liu and Tsai, 2008; Vhurumuku, 2010; Sangsa-ard et al., 2014; Akgun and Kaya, 2020), and science teachers (Abell and Smith, 1994; Leblebicioglu et al., 2021) in both Western and non-Western countries, only a limited number of studies have focused on primary school Students' perceptions about science (e.g., BouJaoude and El Khalick, 1995; Stein and McRobbie, 1997; Kang et al., 2005). In what follows, we present these studies in more detail.

One of the most widely cited studies investigating how students view science is the one conducted by Driver et al. (1996) with primary and high school students (ages 9, 12, and 16) in England. The researchers interviewed same-age pairs of students about their conceptions regarding the purposes of science. They also investigated the extent to which students understand science as a social enterprise. The authors analyzed the data and found that the young students tended to see science as an approach *"providing solutions to technical problems"* (p. 138). It was also shown that students rarely see science as a social enterprise, as they believe that scientists are working in isolation, and that they solve their scientific controversies based (mostly/only) on empirical evidence. Finally, the findings outlined that students perceive science as a process related to the natural sciences.

A similar study conducted by BouJaoude and El Khalick (1995) explored how Lebanese students (N = 80, ages 11–13) define the concept of science. The researchers also investigated Students' perceptions of its usage and its purpose. The students asked to fill out a questionnaire with open-ended questions and to participate in semi-structured interviews, which were based on the following question scheme: *"What is the definition of science?," "What comes to your mind when you hear the word science?," and "What is the purpose of science?."* The findings (from their thematic analysis) showed that the responses of students could be grouped around six core themes (in descending order of percentages): science is *"a course that provides information about humans, animals, plants, earth, sky and stars," "a subject that is divided into other subjects such as physics, chemistry and biology," "a method for doing things," "a subject to teach new things," "a subject that enlightens and gives the truth about nature,"* and *"a subject we study in the classroom."* Regarding the Students' perceptions of the purpose of science, the themes that emerged from the Students' responses (presented in descending order of frequency) were the following: the purpose of science is related to *"academic preparation," "preparation for future careers," "achieving higher social status," "helping people in solving everyday problems," "discovering new things,"* and *"helping people to appreciate and understand nature."* As shown, most of the students defined science as an academic subject and found science useful in terms of preparation for a higher social status. Finally, students stated that science is applied mostly in an academic setting rather than in everyday situations.

In another study, Stein and McRobbie (1997) explored the perceptions of fourth- (N = 20), seventh- (N = 30), ninth- (N = 33), and eleventh- graders (N = 68) attending Australian schools. Students were engaged in half-hour free-writing meetings, discussing the question *"What is science?"* The analysis of the data was done qualitatively through the phenomenological approach. The results of the analysis revealed six categories that described six different perceptions of the concept of science by students (presented from the most unsophisticated to the most sophisticated): science *"as something that is done or learned in school," "as a consumable product," "as a study of the world," "as a process," "as a dynamic knowledge,"* and *"as something that is influenced by the social context."* The results showed that the fourth-graders (9–10 years old) contributed mostly to the first and fourth categories, which reflect conceptions about science that are limited to school science experiences such as specific courses or laboratory activities. Regarding seventh-graders (12–13 years old), the results showed that their answers were limited to the first four categories, with no references to categories five and six, which were perceived as more informed.

Harwell (2000) assessed female ninth-graders' (N = 217) perceptions about science by asking them *"What is science?"* She used Rubba and Harkness (1993, 1996) framework to qualitatively analyze Students' responses under three categories: *"realistic"* (if the response expressed an appropriate view), *"has merit"* (if the statement expressed some acceptable aspects), and *"naïve"* (if the response expressed a view which was inappropriate). The majority of the answers (94%) were categorized as *"naïve"* (including responses that referred to science as a study of subjects or fields; carrying out experiments;

inventing or designing things; finding and using knowledge to make a world a better place). Other girls' responses (5%) were categorized as *"meritorious"* (including answers that referred to science as a body of knowledge that explains the world around us; exploring the unknown; discovering new things: organization of people who have ideas and techniques for discovering new knowledge). Only 14 participants (7%) referred to science through a *"realistic"* viewpoint (including references to science as a systematic, investigative process and the resulting knowledge). The perceptions of the girls in this study indicated a *"naïve"* grasp of science which reflects the tendency of students to view the purpose of science as giving answers to technical problems rather than giving explanations about the world around us (Driver et al., 1996).

Similarly, Elder (2002) explored the perceptions of American primary school students (N = 211, ages 10–11) about the concept of science by asking the following open-ended question: *"What do you think science is?"* Thematic analysis was used to analyze the answers of students. The responses were grouped under three categories: *"poor," "fair,"* and *"good."* The first category (*poor*) incorporated answers stating that science is an end product or that science is a subject to be learned. In the *"poor"* theme, the author categorized unrelated ideas or vague descriptions as well. Second, the category of *"good"* answers included the responses that showed an advanced understanding of the purpose of science (e.g., science is explaining phenomena or science is a learning process). Finally, in the category of *"fair"* answers were placed the responses that were neither developed nor undeveloped. Based on the data, the author found that the three quarters of the students hold a *"poor"* or *"fair"* understanding of the purpose of science.

In a similar study, Kang et al. (2005) explored the perceptions of Korean students (N = 534, age 12) about science. The students were asked to choose which (of the four) option best completes the following sentence: *"Scientists are those who are working on science. To put scientist work in brief, it is…."* The results showed that the majority of sixth-graders considered science to be a process by which scientists *"invent things to make the world a better place to live in"* (naïve perception). The researchers supported that this trend may arise because students may confuse science with technology (the achievements of which facilitate our everyday life). The second most common Students' choice was the *"science is about making new discoveries and adding them to the knowledge of nature."* Finally, the choice *"with science we are investigating natural phenomena and we are explaining the reasons for those phenomena"* (reflecting the developed perception) was preferred by only a minority of students. Overall, the research results showed that few students had developed perceptions of the concept of science, while the majority of them had poor perceptions that (as researchers suggested) may arise from a confusion between science and technology.

In summary, our review revealed that very often students perceive science as something valuable to society, since it solves problems and produces goods that are consumed by humans. It could be said that such perceptions are reflecting a utilitarian/instrumentalist view of science (Park and Lee, 2009) and indicating a way of thinking that conflates science and technology to the point where there is little or no separation between them (Constantinou et al., 2010). The literature review also showed that Students' conceptions about science are often limited to school science experiences. It is also indicated that students very often contextualize science as a school-related phenomenon. As relevant studies suggest, the above findings represent naïve (unsophisticated) perceptions about science (Ryan and Aikenhead, 1992; Holbrook and Rannikmae, 2007).

Students' Perceptions About Scientists and Their Work

Empirical studies conducted in this research field have a long tradition. One of the seminal studies that investigated Students' perceptions of scientists and their work was published by Mead and Métraux (1957) 60 years ago. In their research, 35,000 students attending high schools in the United States were asked to describe their views about science and scientists by completing open-ended sentences. The analysis of Students' responses showed that participants used positive (brilliant, dedicated, essential, etc.) and negative (antisocial, lonely, isolated, etc.) descriptions about scientists. Although the results were enlightening, their qualitative tool was criticized due to (a) the demanding analysis of the data it required and (b) the difficulty that students encountered when verbalizing their descriptions (Schibeci and Sorensen, 1983; Finson et al., 1995).

To overcome these constraints, Chambers (1983), based on Mead and Métraux's (1957) findings, suggested the "Draw-A-Scientist-Test" (DAST) (Chambers, 1983), which is a simple, open-ended projective test that asks people to draw a scientist on a blank sheet (Samaras et al., 2012; Haeusler and Donovan, 2020). Few years later, in order to investigate more systematically the stereotypical characteristics portrayed in children's drawings of scientists, Finson et al. (1995) developed the "Draw-A-Scientist-Checklist" (DAST-C). This checklist provided researchers with a set of stereotypical indicators (Lab Coat, Eyeglasses, Moustache, Laboratory Equipment, etc.) that allowed easy data collection and analysis of Student's drawings. DAST and DAST-C have been used in a plethora of studies worldwide (e.g., Chionas and Emvalotis, 2021; Christidou et al., 2021; Barakat, 2022; Jones and Hite, 2022) and are considered as two of the most well-known, validated tools in the field. It is true that compared to other tools they have significant strengths as: (a) they rely on non-verbal/non-written forms of communication (drawings), which makes them ideal for use with very young participants, (b) they provide the opportunity for easy comparison of different languages, and (c) they require a straightforward data collection process that does not need special experience (Finson et al., 1995; Reinisch et al., 2017; Lamminpää et al., 2020). As a consequence, DAST and DAST-C (and their modified versions, e.g., Farland Smith, 2012; Christidou et al., 2021) have dominated research focusing on the exploration Students' perceptions of scientists.

Systematic reviews regarding DAST studies (e.g., Finson, 2002; Ferguson and Lezotte, 2020) confirm that students, for more than 30 years, are holding common narrow images

of scientists, regardless of their background (Students' age, nationality, culture, gender) (Emvalotis and Koutsianou, 2018; Meyer et al., 2019; Bozzato et al., 2021; Karacam et al., 2021; Leavy and Hourigan, 2021). As research findings highlight, students (very often) draw scientists as bald, middle–aged men with facial hair using test tubes, wearing laboratory coats, carrying out dangerous experiments, working indoors, etc. (Newton and Newton, 1998; Koren and Bar, 2009; Christidou et al., 2012; Emvalotis and Koutsianou, 2018). These results are considered extremely valuable, as they reflect the predominant way children perceive scientists (Chionas and Emvalotis, 2021).

Specifically, in Greece, although the published DAST studies are limited, their results are quite consistent, since almost all of the DAST-C indicators (with slight differences in percentages) are present to some extent, in Greek primary Students' drawings. For example, Samaras et al. (2012) found that primary school students view scientists in a rather stereotypical way, as they mainly depicted them as males who wore glasses and lab coats, and worked in a laboratory setting, which is relevant to natural sciences. Christidou et al. (2012) found that although students used less stereotypical indicators on average than in Samaras et al. (2012), a strong gender stereotype emerged once more, i.e., the majority of students (despite their gender) drew mostly male scientists. What was also interesting in that study was that many students depicted scientists working in the field rather than in a laboratory setting, a result that contradicted Samaras et al.'s (2012) study. More recently, Christidou et al. (2016) found that lower primary school students in Greece used less stereotypical indicators regarding scientists' outfit compared to gender and workplace indicators. The results indicated that most students drew young male scientists wearing casual clothes, without glasses, working in isolation in a laboratory. Emvalotis and Koutsianou (2018) found that Greek students mostly drew male scientists working in a chemistry laboratory, whereas almost half of the students drew scientists wearing lab coats. As the authors highlighted, Greek students in recent years have the tendency to represent scientists wearing casual clothes, with no mustache, beard, or glasses. On the other hand, the Greek participants still hold the narrow image of the chemist who performs experiments and works in isolation. Christidou et al. (2021) assessed Greek primary school Students' images of scientists from a different perspective. They focused on a systematic investigation of scientists' emotions as depicted by children in their drawings. The results showed that scientists were mainly depicted with pleasant, smiling expressions and positive emotions such as pride and happiness, which means that children tend to attribute positive characteristics to scientists' personalities. On the other hand, some participants associated scientists with negative emotions such as anger, anxiety, fear, and sadness, which suggests that students may understand the multidimensional nature of the scientific endeavor. Finally, few children depicted an emotionless scientist.

Although the draw-a-picture approach is a useful technique for investigating perceptions about science and scientists (Padwick et al., 2016), it has some notable drawbacks. For example, researchers doubt whether students portray a particular type of scientist intentionally or they do so because they do not have the drawing skills to portray them differently (Sumrall, 1995; Haeusler and Donovan, 2020). Moreover, it is supported that children may depict sketches that they believe will be easily recognizable by researchers, making them not that authentic (Finson and Pederson, 2011). Furthermore, DAST findings are considered limited, as they do not represent the whole range of student perceptions of scientists (Barman, 2009). As Christidou et al. (2021) highlighted: "*identifying the elements in children's drawings that indicate stereotypic images, sheds light only on part of their thinking and overall mindset*" (p. 3). Students may hold multiple and more complex perceptions of scientists than those depicted in their drawings (Avraamidou, 2013; Nowell et al., 2017). Finally, this method is not sensitive to the identification of personality traits and skills of the scientist, as it focuses mainly on different indicators, as cited above.

Taking these limitations into account, researchers turned to alternative approaches such as interviews (Padwick et al., 2016), questionnaires (Song and Kim, 1999; Özgelen, 2017; Kenneth Jones and Hite, 2020), word association tests (Ateş et al., 2021), biographies analyses (Dagher and Ford, 2005), diamond nine based sorting activities (Padwick et al., 2016) or mixed DAST methods (Farland-Smith and Ledger, 2018). Since such methodological options have a more open approach than the predefined indicators used in DAST-C, their results are quite interesting and fruitful.

For example, Song and Kim (1999) investigated Korean Students' perceptions (N = 1,137, ages 11, 13, 15) about scientists, through a 12 five-point semantic differential scale which represented 12 characteristics of scientists (e.g., *careless—accurate, stupid—intelligent, lazy—industrious,* etc.). The results revealed that Korean students highly ranked scientists in the positive characteristics of the scale, such as intelligence, imagination, and accuracy (i.e., *imaginative, smart, accurate, responsible, and active* were scored positively), while they scored negatively ethical and affective aspects of scientists, as they ranked them high in selfishness and irreligiousness (i.e., *humanist, caregiver, open-minded, fascinating, and religious* were scored slightly negatively). As it was shown, Korean students saw scientists favorably in terms of cognition but negatively in terms of personality, spirituality, and creativity. It is worth noting that when students were asked to compare themselves to scientists, they ranked themselves lower in cognitive qualities but higher in effect and ethics, indicating that they feel largely different from them. Finally, when students were asked to write down the name of their favorite scientist, most of them listed male scientists who were Physicists (e.g., *Einstein, Bell,* etc.), reflecting that students tended to perceive scientists as males working in the natural sciences (Carli et al., 2016).

Walls (2012) examined African American Students' perceptions (N = 23, age 8) of scientists and science through an *"Identify-A-Scientist"* task alongside with interviews. The collected data were used to answer the following questions: *"What do scientists look like?" "What qualities do scientists possess?"* and *"What scientists do?"* The thematic analysis of Students' responses showed that the most frequent emergent themes regarding the appearance of scientists were (in descending order): *eyeglasses, professional attire, gender, lab*

coat, age/maturity. The aforementioned findings showed that the participants' views about scientist appearance could be considered highly stereotypical, given that they were in line with the results of several related studies where similar narrow images about scientists were found (Chambers, 1983; Fung, 2002; Türkmen, 2008; Chionas and Emvalotis, 2021). Results also showed that the three most common traits that the students attributed to scientists were *intelligence, studiousness,* and *happiness*. Although these findings were promising, because they were highlighting a positive view on scientists' personality, it is not sure that they do not reflect (as well) the *"brainy and busy"* stereotypic image of scientists (Özgelen, 2017). Finally, regarding the question "*What scientists do?*" findings revealed that these students related the scientific endeavor with the act of *problem solving, inventing, discovering, experimenting,* and *teaching*. It is interesting to note that although the majority of these practices are taking place in a lab, which is the stereotypical working place of scientists (Ruiz-Mallén et al., 2018), responses of students categorized under the *"teaching"* theme revealed that these students also perceived that scientists can do their works in alternative settings/locations as well (schools, offices, and museums).

Padwick et al. (2016) collected data from students of seven primary schools located in the North of England (N = 350, ages 7–11). Researchers used the Diamond 9 technique (Clark, 2012) to investigate Students' perceptions about scientists. Diamond 9 is an activity in which people rank concepts, phrases, or images in the shape of a diamond and, in that sense, it allows the exploration of individuals' positions on a particular topic (Rockett and Percival, 2002). Regarding the procedure, students were given nine cards presenting nine different character aspects: *clever, cool, creative, kind, friendly, fun, hard-working, sensible, and strange*. At first, students should rank the words into a diamond shape, with *"least like me"* characteristics at the bottom and *"most like me"* traits at the top of the diamond. Afterward, participants should repeat the process, but their second diamond should refer to scientists' characteristics *("least like a scientist"* at the bottom and *"most like a scientist"* at the top). The results revealed that students tend to perceive scientists as *hard-working, clever,* and *creative*, while they do not view scientists as *strange, cool,* and *fun*. Interpreting the results, it could be noted that students have, to some extent, narrow perceptions of scientists such as that they are clever or that they are not funny and are not cool. On the other hand, Students' view scientists as not strange people, which is a result that is counter to the common view of scientists.

Kenneth Jones and Hite (2020) examined Korean Students' (N = 159, ages 5–19) perceptions of scientists by analyzing Students' open-ended answers to the question "*Write down three words that best describe a scientist."* Researchers used Morgenroth et al. (2015) *Motivational Theory of Role Modeling (MTRM)* as a theoretical framework for their study. Students' responses were thematically analyzed under the three core constructs of *MTRM*: *"goal embodiment"* (what scientists do), *"attainability"* (how scientists do it), and *"desirability"* (actions and qualities of scientists). Along with recognizing items that fit into one of the themes, the researchers developed a codebook determining whether Students' responses referred to a positive or negative indicators of each construct. For example, traits like *awesome* and *brave* were coded as positive aspects of the desirability theme while *boring* and *nerd* were treated as negative signs of desirability construct. Or, for example, science activities such as *experimenting, observing* etc. were categorized as positive *"goal embodiment"* aspects whereas *guns, poison, bomb making* were seen as negative aspects of that theme. Results showed high positive frequencies of the goal embodiment construct, and low positive frequencies for the attainability and desirability constructs which means that although, in general, students viewed scientists positively, working in science was not something attainable or desirable.

Another recent analysis conducted by Scholes and Stahl (2020) explored Australian fourth-graders' (N = 45, ages 9–10) perceptions of scientists, science and career in science. In that research, students were interviewed about several themes such as if they wanted to be scientists, what kind of work scientists do and how scientists might look like. The data were analyzed with thematic analysis under the following themes and sub-categories: (a) the *"stereotypical perceptions of scientist"* theme, which divided into *"non-gendered"* and *"paraphernalia"* categories, and (b) the *"non-aspiration to become a scientist"* theme, which separated into *"difficulties and pressure"* and *"science work as physically dangerous."* Results indicated that students used non-gendered language when talking about science and scientists (e.g., *"they"*), which suggests that there may be some reduction in the *"usually a man"* stereotype that students traditionally have about scientists. On the other hand, Students' perceptions of scientists remained grounded in the messy, clever, lab-worker image of a scientist who must work under pressure with specialized and dangerous equipment. According to the authors, these perceptions may reflect a slice of the underlying Students' ideas regarding the masculine characteristics that a scientist should have such as strength, bravery etc.

More recently, Hite and White (2022) investigated Hispanic fourth- and fifth-graders' perceptions of science and scientists before and after environmental after-school club participation. Researchers adopted both quantitative and qualitative techniques to address their research questions. In the qualitative part of their research students were asked to list three words that came to their mind when they thought about a scientist. To analyze the data, a four-theme framework was used. Specifically, Students' responses categorized under the *"positive"* (e.g., brave, dedicated, studious, creative, smart, intelligent, good), *"eccentric"* (crazy, hair, Einstein, serious, busy, specific), *"neutral"* (experiment, test, safety equipment, chemistry, observe, equipment), and *"sinister"* (potions, danger, monsters, aliens, explosives, poisons) themes. As results showed, almost half of the words students used referred positively to scientists. Regarding the categories *"eccentric"* and *"neutral,"* they gathered about a quarter of the Students' answers each. The fewest answers were grouped around the category *"sinister."*

In summary, our review revealed that very often students perceive scientists in a positive manner, but they traditionally provide negative descriptions as well. Although scientists are

perceived as having positive characteristics in general (e.g., regarding their personality traits, skills, abilities), this does not necessarily mean that students view them in a non-stereotypical way. As cited above, many times students believe that scientists have some exceptional abilities and skills or that they are especially gifted individuals. On the other hand, students usually view scientists as crazy, anti-social and eccentric individuals. Overall, scientists are considered by students as people who think and act in a way that is different from *"normal"* people (Tintori and Palomba, 2017).

RESEARCH AIM AND QUESTIONS

The present study attempted to investigate Greek primary school Students' perceptions about science and scientists by applying a more qualitative analysis framework than previous studies. Specifically, in this study an open-ended written questionnaire was administered to fifth- and sixth- grade students and a novel thematic analysis framework was used.

The research questions, which the present study sought to answer, were:

(1) What are the perceptions of Greek fifth- and sixth-graders regarding science?

(2) What are the perceptions of Greek fifth- and sixth-graders regarding scientists and their work?

(3) Do common trends emerge amongst Students' perceptions of science and scientists and the images they have about these issues?

MATERIALS AND METHODS

Participants

The study was conducted using a convenience sample formed by 284 primary school students (137 girls and 147 boys, ages 10–12) from six primary schools located in southern parts of Attica in Greece. One hundred thirteen students were attending fifth grade (65 girls and 68 boys) and 151 students (72 girls and 79 boys) were attending sixth grade, during the 2018–2019 school year. The socioeconomic status of the students was medium. Consent was obtained from the school director and the Students' families.

Procedures

Student participants were administered a written assessment which included an open-ended questionnaire (see "Instruments" section). The instrument was administered by each classroom teacher, and the completion process lasted about half an hour with the presence of the teacher in the classroom. Efforts were made to ensure that teachers did not provide any information to the participants. Participation in this study was entirely voluntary, and each student was assigned a unique identifying number to ensure its anonymity.

Instruments

A questionnaire containing five open questions was developed for this research. These questions have been part of other research schemes in the past (e.g., Harwell, 2000; Lederman and Khishfe, 2002; Walls, 2012). Specifically, participants were asked to briefly describe what they thought science is (*"Could you briefly describe what you think science is?"*). *"Could you briefly describe a great scientific discovery you know about?"* was the second question administered to students. The third and fourth items asked participants to fill a short list providing three adjectives that they would use to describe a scientist, and three adjectives that they would NOT use *("What three adjectives would you use to describe a scientist?," "What three adjectives would NOT you use to describe a scientist?"*). The last question asked students to write about a great scientist they knew (*"Could you please name a great scientist you know?"*).

Data Analysis

The open questions generated qualitative data from children's own responses. Textual data were analyzed using the thematic analysis approach (Braun and Clarke, 2022). Our approach was inductive, as we developed codes and themes from the data content without trying to fit into existing coding schemes (Ho et al., 2017). However, our academic and personal interests meant that analysis has been somewhat deductive (Nowell et al., 2017). At first, in the analysis preparation phase, survey responses were typed into a Microsoft Excel document and organized by question. At this stage, the data were reproduced *"as written"* and were not *"corrected"* in any way (e.g., spelling and grammatical errors have not been changed). The first author carried out a thematic analysis using Braun and Clarke's guidelines (Braun and Clarke, 2021, 2022). He initially read and re-read the data to note *"interesting features."* Then, he moved to more detailed and systematic engagement with the data to spot key features on them (Terry et al., 2017). Afterward, he re-arranged the data to identify broader patterns of meaning or *"potential* (initial) *themes."* These themes were then reviewed, refined, and named. It is worth noting that, at a few points throughout the analysis, the codes were rearranged to better reflect the themes identified in the data. Finally, the second author reviewed the themes and the associated quotes. After discussion meetings, it was decided that Students' responses did accurately capture the essence of each theme, so the process came to an end. The following metrics were used to ensure that authors were not bias dominating the results (**Table 1**).

TABLE 1 | Quality measures that applied in the study.

Quality measures	Actions employed	Description
Credibility	Investigator triangulation (Korstjens and Moser, 2018)	The two authors coded, analyzed, and interpreted the data.
Dependability and Confirmability	Audit trail (Scharp and Sanders, 2019)	We described transparently the research steps taken from the begging of our study to the development and reporting of the findings.

RESULTS

Question 1: "Could You Briefly Describe What You Think Science Is?"

Participants' perceptions about the concept of science were elicited through the question "*Could you briefly describe what you think science is?*" The analysis of Students' textual data revealed four main themes: *"Science as a contributor to human welfare," "Science as objects/products," "Science as set of practices,"* and *"Science as a school subject."* A description of each theme and indicative examples are provided below.

Science as a Contributor to Human Welfare

Under this theme, we grouped those responses related to Students' perceptions reflecting the important role of science in our lives (N = 116, percentage 40%). Many students recognized science as being useful in everyday life, as contributing to problem−solving, and as advancing our society. The following quotations show that students perceive science as an asset for mankind:

"Science is very important for mankind, because it helps people to achieve different types of goals." (P_{31})

"Science leads to an improvement of the quality of life for mankind." (P_{36})

"Science makes the world better and has contributed greatly to our knowledge for the physical world. Without it there would be no progress." (P_{39}).

"Science is knowledge which is important for the progress of mankind." (P_{48})

"It is very important for mankind because it has offered a lot to us." (P_{156})

A number of respondents expressed the view that science appears to be necessary in our present-day society and that science has a positive impact on it. For example:

"Science is very important for our society." (P_{61})

"When research is done that will help our society." (P_{116})

"Science is when one discovers something good for society." (P_{130})

"Science is important. It helps our society move forward." (P_{213})

Others commented that science might be helpful to any person in the solving of today's problems. In that sense, some students reported that the importance of science lies in its usefulness in solving problems generally. The following responses offer such exemplars:

"Science solves our everyday problems." (P_{209})

"Science solves the strange problems that confuse ordinary people." (P_{84})

"Science is something we use every day, and which solves problems in our world." (P_{228})

"Science helps people solve problems, such as environmental problems." (P_{229})

"Science is the solution to our life's problems. It answers our questions." (P_{241})

Science as Objects/Products

Science as objects was the second most often mentioned description of science (N = 86, percentage 30%). The Students' responses under this theme contained references to scientific discoveries, scientific products, and technological achievements. Some students reported general descriptions of objects, for example:

"Science is the discoveries, and they require a lot of work." (P_{140})

"Science is the various discoveries that scientists make." (P_{128})

"Science is when a person discovers a new invention." (P_{188})

On the other hand, some students referred specifically to technological achievements and everyday equipment with which they usually interact. In that case, Students' description of the concept of science reflected an explicit acknowledgment of a relationship with technology. For example:

"Science is important because without it there would not be Internet, Wi-Fi, mobile phones and computers." (P_{42})

"Science is creativity with which various discoveries are made... such as technology, phones, cars, light and many other things that are useful or even useless to us." (P_{144})

"Science helps people in various ways... like car and television." (P_{167})

Science as a Set of Practices

On this particular theme, students referred to science as a set of different practices (N = 64, percentage 20%). Several respondents expressed the view that science is based on experimentation:

"Science is experiments." ($P_{7,148}$)

"Science is experiments that determine our future." (P_{15})

"Science is experiments and discoveries that help people or do not help them." (P_{43})

Other students referred to scientific practices that precede or follow the experimentation phase but are important parts of the so-called *"scientific method,"* as taught in the science class. For instance:

"Science is a method. Somebody does experiments, observes, and then concludes." (P_{164})

"Science is experiments which support a scientific theory." (P_{184})

"Science is various theories that when we merge them we draw conclusions that help us to understand some things better." (P_{202})

"Science is a series of inquiry steps and observations, until scientists reach conclusions." (P_{246})

Science as a School Subject

In this category, we included Students' responses naming various scientific research fields, such as physics, chemistry, biology, mathematics, psychology and linguistics, medicine, and astronomy (N = 35, percentage 12%).

"Science is physics and mathematics. If you connect them, you can solve everything." (P_{41})

"Science is a combination of biology, physics, chemistry, and mathematics." (P_{42})

"Science is studied by scientists such as doctors, chemists, and astronomers." (P_{115})

"Science is chemistry, mathematics, history, biology, psychology, and linguistics." (P_{257})

Also, in this category were included the descriptions of the students who gave specific examples of school subjects or academic courses, such as physics, chemistry, mathematics, biology, etc., or made general type formalities. Some responses in this category are presented below.

"Science is the subjects taught in universities." (P_{163})

"Science is some courses taught in schools." (P_{194})

"Science is not a specific subject. Science is many subjects for example linguistics, mathematics, biology, physics, and more." (P_{250})

"Science is all lessons together." (P_{252})

Finally, in this category, we have included responses referring indirectly to specific scientific disciplines. Some indicative examples are the following.

"Science is the study of the environment and natural phenomena." (P_{53})

"Science concerns the professions that find solutions to some diseases and deal with the human body." (P_{284})

Question 2: "Could You Briefly Describe a Great Scientific Discovery You Know About?"

In regard to Question 2, Students' responses to thematic analysis revealed two general themes. These themes were subsequently named: (1) *"Great Discoveries"* and (2) *"Great Inventions."* Under the first theme, we grouped responses that described various discoveries. The term *"discovery"* in our study referred to *"the act of becoming aware of something previously existing but unknown"* (Noé, 2002, p.31). On the other hand, we conceptualized the term *"invention"* as a creative process occurring within a technological milieu and drives to a novel solution that improves the quality of our life (Corazza and von Thienen, 2021). So, *"Great Inventions"* theme covered responses that highlighted such solutions.

Great Discoveries

The theme *"Great Discoveries"* consisted of responses that described discoveries from various scientific fields. We have further thematically analyzed that theme to differentiate between *(1a) "Space Science Discoveries," (1b) "Earth Science Discoveries,"* and *(1c) "Physics Discoveries."* **Table 2** provides basic information about the aforementioned subthemes alongside some of the indicative examples from within these subthemes.

Great Inventions

Under the *"Great Inventions"* theme, we identified four subthemes, including *(2a) "Health Science Inventions," (2b) "Information and Communication Science Inventions," (2c) "Domestic Life Inventions,"* and *(2d) "Transportation Inventions."* Indicative examples associated with these subthemes are presented in **Table 3**.

Question 3: "What Three Adjectives Would You Use to Describe a Scientist?"

Results regarding the third question showed that students talked about scientists by using various descriptions. Because students mentioned a total of 150 different characteristics, the richness of perceptions associated with scientists was considered significantly high. Our analysis showed that students' responses could be grouped under the following core themes: (1) *"Personality,"* (2) *"Skills,"* (3) *"Work,"* and (4) *"Appearance."* We further thematically analyzed the *"Personality"* theme to differentiate between *"Personality—Cognitive"* (clever, smart, genius, etc.) and *"Personality—Social"* (boring, annoying, etc.). Twenty-two responses did not seem to fit within these main themes, so we created the *"Other"* theme to include these codes. In **Table 4**, theme descriptions and indicative examples of codes included in each theme are presented.

Our descriptive analysis of data showed that *smart* or synonyms such as *clever*, *intelligent,* etc. were the most reported characteristics (∼33%). *Creative* (∼7%) was the second most frequent reported code. A similar percentage of students reported that scientists are considered as *patient, careful*, *hard-working, inventive,* or *serious* persons (3–4%). The next Word Cloud (**Figure 1**) is plotted to present the most frequently referred characteristics (above 1%).

Regarding the type of characteristics that students used to describe scientists, we found that "*Personality*" was the most reported category/theme (428 out of 770). Looking in more detail across the *"Personality"* theme, we found that 36.9% of words referred to cognitive traits (*"Personality—Cognitive"* theme) and 18.7% referred to social characteristics (*"Personality—Social"* theme). Three hundred two of the 770 responses (39.2%) focused on scientists' skills. As a result, "*Skills*" was the second most frequently reported theme. Finally, descriptive analysis showed that less than 3% of Students' responses were aligned with "*Work*" and *"Appearance"* codes. The above findings are presented in the following diagram (**Figure 2**).

Question 4: "What Three Adjectives Would You NOT Use to Describe a Scientist?"

Thematic analysis of the questionnaire data identified 178 words represented in children's responses to the question *"What three adjectives would you NOT use to describe a scientist?."* These words were classified by the researchers under the same four themes and subthemes as shown in **Table 4**. **Table 5** shows indicative examples for each theme.

TABLE 2 | Great discoveries' subthemes, their descriptions, and indicative examples.

Subtheme	Description	Indicative examples
Space science discoveries	Responses that describe discoveries related to space science.	*"Liquid water exists on Mars."* (P_{122}) *"Pluto that turned red on February 5, 2010."* (P_{144})
Earth science discoveries	Answers that contain discoveries related to the scientific field of geography.	*"The Earth is round."* (P_{69}) *"The discovery that the Earth is not flat but round"* (P_{259}) *"The discovery of America by Columbus."* (P_{262}) *"Ozone depletion."* (P_{262})
Physics discoveries	Responses referred to physics discoveries.	*"Newton who was in his room and passed the light through a prism and the reflection in the white cloth created the rainbow."* (P_{169}) *"The phenomenon of reflection and diffusion of light. When a ray of light meets a smooth and glossy surface it is reflected, while when it meets a rough surface, it diffuses."* (P_{273}) *"Electromagnetism discovered by Oersted and Faraday."* (P_{33}) *"Molecules are made up of smaller particles. Atoms are made up of the nucleus and the electrons that move around the nucleus."* (P_{252}) *"That Newton discovered gravity."* (P_{19})

TABLE 3 | Great inventions' subthemes, their descriptions, and indicative examples.

Subtheme name	Subtheme description	Indicative examples
Health science inventions	Responses that mention inventions related to health sciences (medicine, dentistry, pharmacy).	*"Drugs used to treat cancer."* (P_{117}) *"Drugs that stop migraine headaches."* (P_{32}) *"Medicines that can cure diseases."* (P_{226}) *"Thermometers"* (P_4) *"Penicillin."* (P_{91})
Information and communication science inventions	Responses that state inventions for information reception, recording, and communications.	*"The personal computer."* (P_{262}) *"The telephone."* (P_{262}) *"The radio."* (P_{262}) *"The television."* (P_{262})
Domestic life inventions	Responses describing inventions that help people to meet the basic needs of a domestic life.	*"The washing machines."* (P_{262}) *"The fridge."* (P_{262}) *"The light bulb."* (P_{259})
Transportation inventions	Responses referring to inventions, which allow transportation.	*"The car."* (P_{262}) *"The airplane."* (P_{262}) *"The wheel."* (P_{262})

TABLE 4 | Framework for analysis of children's responses to *"What three adjectives would you use to describe a scientist?"*

Theme name	Theme description	Indicative examples
Personality	Words that described cognitive and social characteristics of scientists.	Cognitive: Smart, Intelligent, Genius, Brainy, Clever, Wise Social: Enthusiastic, Polite, Conversational, Fascinating, Open, Boring, Different, Strange, Crazy, Alone, Conservative, Deranged
Skills	Answers referring to competences and abilities attributed to scientists.	Creative, Patient, Careful, Hardworking, Concentrated, Devoted, Responsible, Focused, Productive, Cautious, Well Educated, Studious, Bookish
Work	Words related to specific fields of study.	Astrophysicist, Doctor, Teacher, Physicist
Appearance	Items related to physical appearance of scientists.	Thin, Handsome, Slim, White-haired, Dirty, Beard, Thick, Tall, Well dressed, Short, Untidy
Other	Any word that does not fit into one of the preceding categories.	Rich, Awake, Perfect, Fantastic, Justified

Our analysis showed that scientists were mainly described as people that are not *stupid* (∼15%). In a lesser percentage (∼7%) students said that scientists are not *lazy* or are not *irresponsible*. Between 2 and 5%, we found various words that students believe that don't reflect scientists' characteristics such as *boring, careless, social, crazy, fool,* and *illiterate*. With the following Word Cloud (**Figure 3**), we have visualized the most frequently discussed characteristics (above 1%).

Regarding the type of characteristics that students said that do not describe scientists, "*Personality*" theme was, once more, the most reported category/theme (53.9%). More specifically, 21.6% of words referred to cognitive traits ("*Personality—Cognitive*" theme) and 32.3% referred to social characteristics ("*Personality—Social*" theme). Thirty seven percent of students used characteristics categorized under the "*Skills*" theme. Thirty-four students used «"*Appearance*" codes (5%) in their

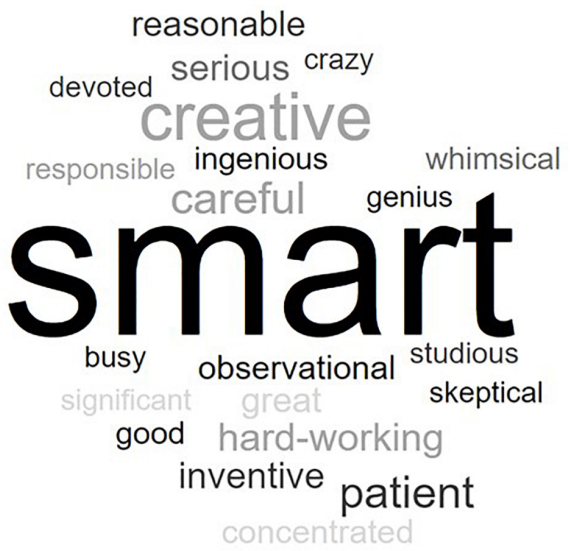

FIGURE 1 | Word Cloud presenting the most frequent descriptions of scientists.

descriptions. Twenty-six responses included to the *"Other"* theme. The following pie chart (**Figure 4**) shows the frequencies of the aforementioned core categories.

Question 5: "Could You Please Name a Great Scientist You Know?"

In Question 5, students were asked to name a great scientist they knew. The collected answers to this question were 225 (79.22%). Students who didn't respond were 59 (20.78%). In total, 28 different names of scientists were identified. **Table 6** presents the frequency distributions of the names of scientists whose percentage exceeded 1%.

DISCUSSION

This study sought to understand how Greek primary school students perceive science, scientists, and their work. Fifth- and sixth-graders were asked to complete a written questionnaire containing five open-ended questions. The collected data were analyzed through the thematic analysis method.

The findings revealed that the vast majority of the students perceived science primarily as a means for improving and evolving their lives (*"science as a contributor to human welfare"*), a result which is in line with those from similar studies (Driver et al., 1996; Stein and McRobbie, 1997; Aikenhead, 2005; Padwick et al., 2016). Recent research also showed that scientists are perceived by students to be servants of humanity and altruistic people who are dedicated to serving the welfare of society (Koren and Bar, 2009; Bartoszeck and Bartoszeck, 2017). We believe that these results could be related to the media influence on Students' views about science and scientists (Lee and Scheufele, 2006; Silver and Rushton, 2008) for at least two reasons. First, nowadays scientific topics are more frequently presented in the media than in the past (Gelmez Burakgazi and Yildirim, 2014). Since they increasingly put technological innovations under the auspices of the scientific sphere, they (indirectly) promote perceptions of sciences' usefulness for humanity. Second, such ideas are very close to scientist's depictions that are presented in the traditional media. As scholars highlight, this "heroic scientist" archetype is very often reproduced (Nisbet and Dudo, 2013;

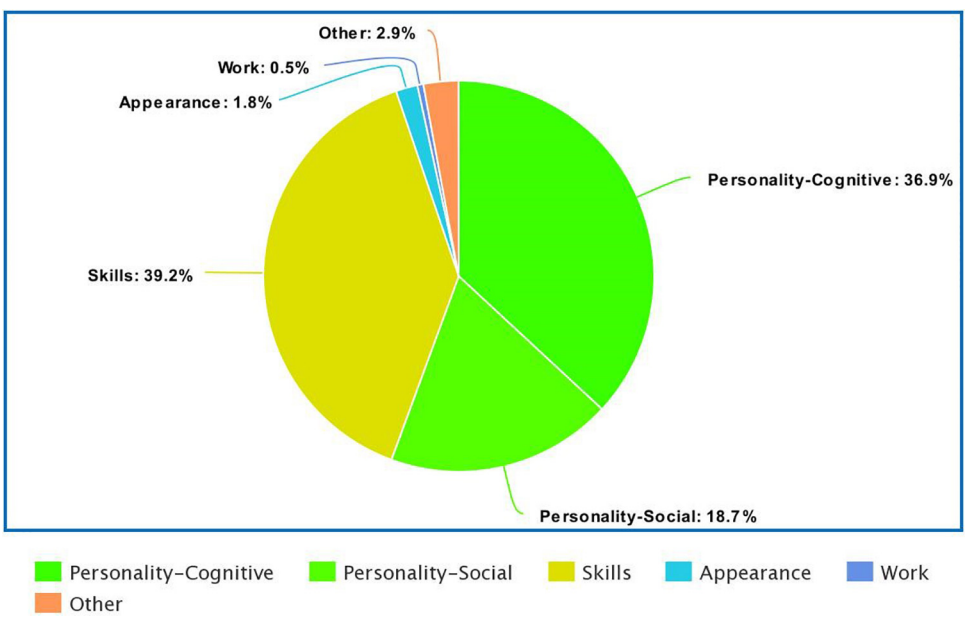

FIGURE 2 | Types of descriptions of scientists (organized by themes).

TABLE 5 | Framework for analysis of children's responses to *"What three adjectives would you NOT use to describe a scientist?"*

Theme name	Indicative examples
Personality	Cognitive: Stupid, Moron, Idiot, Brainless, Fool, Empty-headed Social: Forgettable, Boring, Social, Funny, Immature, Insignificant, Unimportant
Skills	Lazy, Careless, Impatient, Superficial, Irresponsible, Illiterate, Uneducated, Work-shy, Remiss, Scatterbrained
Work	Trucker, Secretary
Appearance	Thick, Tall, Athletic, Ugly, Handsome. Body builder, Short, Thin, Black-haired, Bald, Strong
Other	Rich, Poor, Tired, Naughty

FIGURE 3 | Word Cloud presenting the most frequent words that do NOT describe scientists.

Fujiwara et al., 2022), and in that sense, it is possible to have influenced Students' views.

Our study also found that many students, as expected, described science in the light of its achievements or through references to its products, which is in line with the results of recent studies (Newton and Newton, 1998; Elder, 2002). This result seems to be in agreement with educational reports which claim that science *"as a product"* or *"body of knowledge"* is an extremely familiar dimension of science for students (Bell, 2009). Unfortunately, this trend may reflect (as well) the traditional confusion that exists among students between the concepts of science and technology (Ryan and Aikenhead, 1992; Kang et al., 2005), as they often believe that it is the science that provides our society with gadgets and other practical solutions (Clough, 2000). It is worth noting that the above trend is in line with the results of many studies that asked students to depict a scientist while working, since very often technological products are present in Students' drawings (Samaras et al., 2012; Leblebicioglu et al., 2021), while "symbols of technology" are regarded as one of the basic DAST-C stereotypical indicators assessed in relevant studies. Concluding, we should note that the above perceptions are considered as naïve by researchers and are expressed by a large proportion of students of this age worldwide (Elder, 2002; Kang et al., 2005).

The students also linked the concept of science with various disciplines that were mainly referred to natural Sciences (biology, chemistry, physics), a finding that has emerged in the past from other researchers and corresponds to a stereotypical and unsophisticated perception of science (BouJaoude and El Khalick, 1995; Armağan, 2017). This outcome also indicates that the Greek Students' written responses presented considerable similarities with children's pictorial representations of the scientists both in Greece (Samaras et al., 2012; Christidou et al., 2016; Emvalotis and Koutsianou, 2018) and worldwide (Blagdanic et al., 2019; Bozzato et al., 2021), i.e., very often students draw scientists as professionals working in the fields of physics, chemistry, and biology and are surrounded by flasks, test tubes, bottles etc. Previous studies have also captured that the activities related to social sciences and humanities are very hard to be presented in drawing (Blagdanic et al., 2019). Our results extend to these findings, since the written answers of Greek students were rarely related to these fields (Christidou et al., 2012; Samaras et al., 2012) which shows that, traditionally, students believe that science is related (mostly) to the study of the natural world (Emvalotis and Koutsianou, 2018).

Finally, a small part of the Students' responses included descriptions related to the processes of science, descriptions that are considered sophisticated (Elder, 2002; Kang et al., 2005). This means that students find it difficult to describe in a few words the meaning of science through its processes, which was not the case when drawings were used as a tool to collect data about children's perceptions of scientists and their work in other studies. For example, recently Lamminpää et al. (2020) found that 95 of the 104 evaluated children's drawings included portrayals of some kind of scientific process (experimenting, discussing results, etc.), a result that is contrary to our finding. It is also interesting that although Students' responses in that category were few, these were focused upon the delineation of activities that themselves have encountered through school science and as a result the emphasis of their responses was given on inquiry processes. This finding contradicts the notion that many students may perceive a mismatch between what it means to do science in the classroom and what science in real life entails (Zhai et al., 2014) as they directly referred to well-known science classroom processes to conceptualize the scientific endeavor. The results from the question of scientific discoveries showed that the students presented discoveries mainly in the field of natural sciences (Space Science, Earth Science, Physics). The above areas, as shown by previous research (Chambers, 1983; Song and Kim, 1999; Rodari, 2007; Narayan et al., 2009; Emvalotis and Koutsianou, 2018), seem to reflect areas that students stereotypically perceive as key areas of specialization of scientists. At the same time, a large part of the students, as mentioned above, did not seem to distinguish science from technology, since technological innovations were presented in the place of discoveries. This finding is similar to

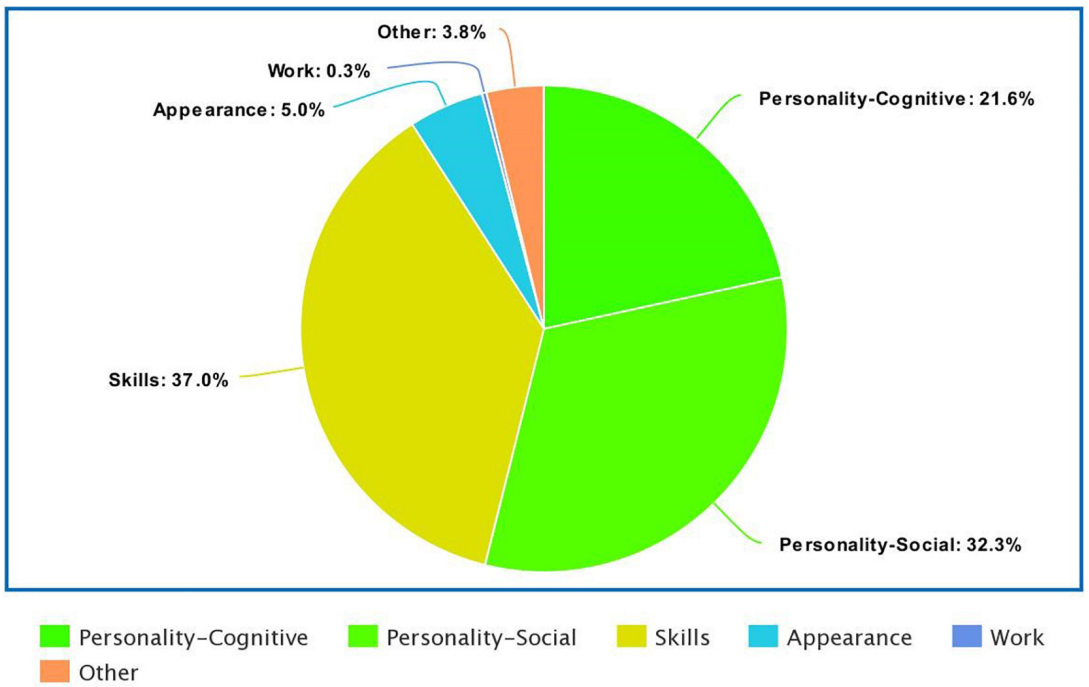

FIGURE 4 | Types of words used that do NOT describe scientists (organized by themes).

those of Ryan and Aikenhead (1992), Rennie and Jarvis (1995), and Constantinou et al. (2010) who found that students fail to distinguish between science and technology concepts which in many cases were used interchangeably.

Our study also revealed that positive scientists' characteristics were relatively common in Students' responses, and negative traits were rare. Though not entirely surprising in light of other recent studies (Archer et al., 2013; Shimwell et al., 2021), we found that the scarcity of negative characteristics in our sample to be notable. Furthermore, the positive descriptions students used to describe scientists fell into various categories: personal characteristics, social characteristics, skills, and appearance, which means that students may generally view scientists positively. While this may seem encouraging at first, it may also conceal stereotypes about Students' understanding of scientists. For example, our findings showed that most participants seeing scientists as purely *"clever"* and *"intelligent"* (or not stupid). These traits might reflect a stereotypical view about scientists' mental abilities as they indicate that scientists have some kind of *"special brain"* (Lei et al., 2019). In this context, students also mentioned that scientists are *"hardworking," "dedicated,"* and *"patient"* people (or that they are not lazy and impatient individuals) which are some other common positive stereotypes that students have for scientists (Schinske et al., 2015).

It is also interesting that contrary to the findings of earlier studies (Karacam, 2016; Woods-Townsend et al., 2016) we did not find that students view scientists as *"boring"* people, but in contrast they characterized them as interesting personalities. It is also worth noting that the trend of viewing scientists as *"mad"* or *"crazy"* people (Tuckey, 1992; Ruiz-Mallén and Escalas, 2012) was weak in our study, which is consistent with what has been found in recent studies (Emvalotis and Koutsianou, 2018). This finding may be explained by the idea that an increasing number of films and books portray scientists as people who, in addition to science, have fun, relax, have favorite activities, and have a family (Haynes, 2016). Nonetheless, despite the fact that images of scientists have improved over time, many representations continue to overemphasize specific attributes that may mislead individuals' perceptions of science and scientists. Misleading images of scientists, whether good or negative, confuse the

TABLE 6 | Most common great scientists' names.

Scientists' names	Frequency	Percentage (%)
Einstein	117	52
Hawking	39	17.30
Edison	9	4.00
Bell	8	3.55
Volta	7	3.11
Lakhdar	6	2.66
Newton	6	2.66
Celsius	4	1.77
Curie	4	1.77
Oersted	4	1.77
Franklin	3	1.33
Tesla	3	1.33

Responses below 1%: Da Vinci, Verne, Colombus, Fahrenheit, Faraday, Ford, Frankenstein, Fraunhofer, Galileo, van Gogh, Gray, Gutenberg, Voltaire, Aristotle, Archimedes, Charalampakis.

students not only about the work scientists conduct, but also about their character traits (Fujiwara et al., 2022). For example, in our research, students described scientists as non-social people, which confirms the *"lonely scientist"* stereotype that is very common in media (Nisbet and Dudo, 2013).

Our results also showed that the students described the scientists mainly through their personality traits and not that much through their skills, their appearance, or their specialty. The present results are significant in at least two major respects. First, the students used only few adjectives about the appearance of the scientists, which did not reveal any tendency, but instead seemed to describe them in a variety of ways (Christidou et al., 2016; Emvalotis and Koutsianou, 2018). This is a key difference between the data in this study and the DAST studies. Also, it seems that our data did not provide descriptions that reflected stereotypes, such as a scientist being a person with a laboratory coat and gray hair which are some of the stereotypical images that students use when depicting scientists. On the one hand, this may be due to the fact that the children were asked to provide a descriptive text rather than a drawing, so they did not have to choose the clothes or physical features for the scientist. On the other hand, this finding, while preliminary, may indicate that more and more students are seeing scientists in a way that goes beyond the traditional (male, middle-aged, bald, etc.) (Samaras et al., 2012; Emvalotis and Koutsianou, 2018). Second, students cited scientists' skills in a lesser extent than their personality characteristics. In our view, the most compelling explanation for the present finding is that children may think that scientists have some innate personality qualities (Dewitt et al., 2012; Archer et al., 2013) that seem to be conceived as more important than the non-innate skills (Schinske et al., 2016). These results are not very encouraging because, if this is the case, then students who do not consider themselves belonging to this *"special group"* of people may not get engaged in science in the future (Archer et al., 2010, 2013).

Regarding the famous scientist, the majority of students reported male scientists, a finding that is consistent with the results of several studies where drawings were used as research data (Türkmen, 2008; Christidou et al., 2012; Emvalotis and Koutsianou, 2018). In that sense, we could argue that no matter the data collection method, i.e., drawings or verbal/written responses, the male stereotype of a scientist dominates the minds of the students. As many studies confirm, the public visual image of science worldwide is largely male (Mitchell and McKinnon, 2019), a tendency that also has been found in the recent study of Christidou et al. (2019), where one thousand publicly available photos of scientific researchers located in Greek archives have been analyzed. The names of scientists that students cited were also interesting, because the vast majority of them limited almost exclusively to scientists that exist in the Greek science textbooks of the fifth and sixth grade (Einstein, Edison, Bell, Volta, Newton, Celsius, Curie, Oersted, Franklin, Tesla), a finding that can be explained in the context of the influence that the contents of the school curriculum have on Students' perceptions of science and scientists (She, 1995; Türkmen, 2008; Yacoubian et al., 2017). Similar studies with teachers revealed similar trends regarding their favorite scientist, so it is possible that students' perceptions may have been influenced by their teacher's views as well (Yalcin, 2012; Gheith and Aljaberi, 2019; El Takach and Yacoubian, 2020). Albert Einstein seems to be still the most popular scientist for students, a result that is in line with other recent studies (Song and Kim, 1999; El Takach and Yacoubian, 2020; Ivgin et al., 2021). This finding was more or less expected because students very often view scientists as middle-aged people with wacky hair and mustaches, which means that Einstein-like appearances of the scientist are very popular to them (Ozel, 2012; Blagdanic et al., 2019). Also of interest was the high frequency of references to Stephen Hawking, who, in contrast to the results of similar studies appeared to be the second most frequently cited scientist among the Greek students. This finding contradicts the results of other studies that found almost complete absence of contemporary scientists in the citations of students (El Takach and Yacoubian, 2020; Ivgin et al., 2021). This inconsistency may be due to the fact that the media referred frequently to Stephen Hawking's death, which coincided with the time of our investigation. As it is mentioned earlier, media influence Students' perceptions of science and scientists (Buldu, 2006; Zhai et al., 2014), so it is possible that the students were controlled. Finally, our results showed that the participants tend to imagine prototypical examples of scientists working in the natural sciences, which supports similar stereotypical evidence from previous studies (Ozel, 2012; Samaras et al., 2012; Carli et al., 2016; Blagdanic et al., 2019).

Educational Implications

Our findings contribute to the existing literature in several ways. Knowing what fifth- and sixth-graders' perceptions of science and scientists are, we created a starting point for how Students' practice and be supported by their teachers. The results highlighted that interventions to challenge Students' perceptions about science and scientists are needed, mainly targeting to the narrow image of the *"smart"* charismatic scientist, who works exclusively in the field of natural sciences. In this context, teachers are advised to carry out a variety of in and out school activities that will help breaking these narrow views (e.g., visits to the workplace of scientists, meetings with scientists in the classroom etc.). It is supported that such interactions allow students to view scientists as ordinary people, who are working in a wide range of scientific areas (Woods-Townsend et al., 2016; Shimwell et al., 2021). Regarding the naïve ideas that students have about science, and the difficulty to distinguish between science and technology, it is strongly suggested that teachers (and prospective teachers) should become more informed on such issues and also more capable to design appropriate learning environments that will allow students to develop more sophisticated views about science and technology (Constantinou et al., 2010). Our results can also be used by National Governmental Institutions (such as Ministry of Education, Institute of Educational Policy, etc.) in various ways. Given that the newly introduced law for the upgrading of Greek schools allows free choice of school materials from approved school textbooks (Eurydice, 2022), we suggest that textbook authors must carefully plan what they are going to include in new textbooks in order to prevent reinforcing misleading information and stereotypes. It is also suggested that

various national stakeholders, such as Photodentro, which is the Greek National Educational Content Aggregator for Primary and Secondary education (Karagiannidis et al., 2022) should include appropriate visual, print, and digital media educational material, with which a more realistic view will be attributed to science and scientists.

Limitations and Future Research Directions

The study reported here has a number of limitations. First, regarding the students participated in our work, we selected participants conveniently. As a result, the findings of the present study should be interpreted with caution as they might not be appropriately generalizable beyond the selected participants. Further research is required to determine whether they can apply more broadly to other groups of participants. This study was also limited by the absence of more data. As we limited students to briefly answer our questions, or to provide a single word to describe scientists, we were not allowed to gain a better understanding of what they really had in mind. To overcome this issue, future studies may wish to use focus groups or one on one interviews in order to encourage students to think deeply and include more details to their responses. A further limitation concerns the instrument was used to assess the perceptions held by the students. As it is relatively new in its use, compared to DAST-C (Chambers, 1983) or V-NOS (Lederman et al., 2002), it should be thoroughly tested for its effectiveness by future researchers. Finally, the present study does not uncover the mechanisms by which varying Students' perceptions about science and scientists were shaped. It is proposed that future research should focus on the influence of various factors (Students' socio-economic background, parents' academic level, teachers' views etc.) may have in Students' perceptions of science and scientists.

DATA AVAILABILITY STATEMENT

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

ETHICS STATEMENT

The studies involving human participants were reviewed and approved by the Research Ethics Committee—Department of Primary Education, School of Education Sciences, University of Ioannina. Written informed consent to participate in this study was provided by the participants or their legal guardian/next of kin.

AUTHOR CONTRIBUTIONS

Both authors listed have made a substantial, direct, and intellectual contribution to the work, and approved it for publication.

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