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Students' perception of scientists through mind maps: A study on creativity in social studies lessons

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Abstract

Scientists have advanced society in various fields through their inventions and ongoing research. In this context, identifying and addressing misconceptions acquired at an early age is essential to understanding scientists accurately. With this study we aimed to examine students' perceptions of scientists as reflected in their mind maps within the framework of the social studies curriculum. The study was conducted in the city centre of Yalova, Turkey, with participation from Fifth-Grade secondary school students. A phenomenological approach, as a qualitative research design, was adopted in the study. Data were collected using mind maps and structured interview forms created by the students. The data were coded and analysed using content analysis. The findings reveal 5 key themes in students' perceptions of scientists: creativity skills, success discipline, philosophical aspects, physical characteristics, and personality traits. Students often described scientists as male individuals working in an enclosed physical space. Moreover, during the interviews, scientists were portrayed predominantly in a positive light. Although the Fifth-Grade students' perceptions of scientists reflected a multidimensional understanding, they remained limited in terms of physical representation and were largely shaped by influences from school, media, and cultural elements. In this context, we recommend that science workshops are established in schools to help reshape perceptions of scientists and scientific activities. Additionally, school- and project-based activities that bring students together with practicing scientists could be implemented to enhance engagement and authenticity in science education.

Keywords: mind maps; science; scientists; secondary school students; social studies; student perception

Introduction

An effective education system primarily teaches people the art of thinking. It aims to promote critical thinking that shapes individual identity, rather than encouraging the retention of static and memorised information (Anderson & Krathwohl, 2001). Learning is a process that accompanies the development of critical thinking skills. Individuals acquire knowledge through various learning styles. Studies in the literature suggest that meaningful learning occurs through experience, particularly when critical thinking is actively involved (Eggen & Kauchak, 1997; McAuliffe & Erikson, 2011; South African Qualifications Authority [SAQA], 1997; Wekwete & Higgs, 2024). In addition, methods and techniques such as visual, auditory, and tactile modalities can support the transfer of knowledge (Barbe & Milone, 1980).

Social studies is one of the subjects in which students are most intellectually engaged in both learning and teaching processes. The social studies curriculum aims to cultivate active and productive citizens who are aware of and exercise their rights and responsibilities (Pugh, McGuire, Butler, Castillo, Moore, Ramirez & Russac, 2023). It encompasses a variety of disciplines, including social studies, history, geography, and citizenship. These disciplines aim to help students acquire a wide range of concepts. Researchers emphasise the importance of students thinking critically during concept learning and taking appropriate steps to concretise abstract ideas (Klausmeier, 1992). Therefore, students' opinions and thoughts about a given concept or subject reflect their level of understanding. Contemporary educational approaches aim to present concepts with rich content and facilitate learning in an engaging and meaningful manner. In this context, mind maps serve as visual tools that help organise and associate themes or concepts (Steyn & De Boer, 1998; Tucker, Armstrong & Massad, 2010).

Mind Maps

Tony Buzan developed mind maps, which have recently been used frequently in summarising course topics and teaching concepts. These are visual and holistic thinking tools aligned with brain function (Buzan & Buzan, 2007). By using mind maps, students can express their views on a concept or subject and enhance their creative thinking skills (Grant & Archer, 2019). In this development progressing in a dynamic process, the individual can sometimes have a positive and constructive mindset, sometimes harsh, rigid, and difficult (Sheffield, Cook, Ricchezza, Rocabado & Akiwumi, 2021; Villar & Guppy, 2015). Mind maps may be effectively used to summarise subjects, facilitate concept learning, enhance thinking and creativity skills, and support problem-solving processes (Buzan & Buzan, 2007). Thus, mind maps allow learners to view subjects and concepts more holistically during the learning process (Edwards & Copper, 2010).

Researchers argue that visual elements, such as pictures and structured diagrams, are more effective than text in facilitating concept learning (Davies, 2011). For example, components such as titles, themes, arrows, and connections arranged around a central topic can form a structured schema, as seen in a mind map (Scavarda,

Bouzdine-Chameeva, Goldstein, Hays & Hill, 2004). Mind maps designed in this manner help to externalise and visualise cognitive processes (Fox & Schirmacher, 2015).

The interdisciplinary structure of the social studies curriculum provides an appropriate context for the use of mind maps. When used effectively in social studies courses, mind maps can make the learning process more meaningful and support the development of cognitive skills related to concept learning. For this reason, researchers suggest using mind maps in social studies courses to uncover students' knowledge and skills regarding science

and scientists.

Social Studies and Scientist

In Turkey, one of the subjects that incorporates content related to scientists is the social studies curriculum. The social studies curriculum addresses science, scientists, and scientific inventions (Ministry of National Education [MoNE], 2018). By introducing these concepts, the aim with the curriculum is to foster interest in diverse scientific fields, research practices, and cognitive development. Revisions to social studies textbooks can highlight the discoveries of prominent scientists and their contributions to scientific knowledge.

Scientist		Studies
Thomas Edison	→	He contributed to the invention of light bulbs.
Leonardo Da Vinci	→	He designed flying vehicles.
Newton	→	He discovered gravity.
Bruno	→	He observed the sky.
Ibn Khaldun	→	He is the founder of social science.
Ibn Sina	→	He conducted studies in the field of medicine.
Al-Khazini	→	He is the inventor of the precision scale.
Johann Gutenberg	→	He invented the printing press.
Thales	→	He proposed water as a single material substance.
Pythagoras	→	He was the first to suggest that the Earth revolves around the Sun and is round.
Al-Biruni	→	He determined the shape and diameter of the Earth.
Galileo	→	He argued that the Earth and other planets revolve around the Sun.

Figure 1 Prominent scientists and their contributions as presented in social studies textbooks

An examination of Figure 1 shows that the social studies curriculum includes scientists and their discoveries in multiple fields. The curriculum frequently highlights scientists distinguished by their work in astronomy, geography, and physics, emphasising the significance of their contributions to world history.

With this study we aimed to explore secondary school students' perceptions of scientists using mind maps. It is significant for concept teaching, particularly in identifying and preventing misconceptions. Historically, the number of studies examining students' perceptions of scientists has increased since 1957 (Finson, 2002), however, research within the field of social studies remains limited. Similarly, identifying and analysing students' perceptions of scientists through mind maps is important for enhancing their creative thinking skills (Miller, PH, Blessing & Schwartz, 2006). The literature includes studies indicating that students are interested in learning about scientists and scientific topics (Bang, Wong & Jeffery, 2014; Buldu, 2006; Chambers, 1983; Song & Kim, 1999). Additionally, existing studies discuss students' visual perceptions of science and scientists, as well

as the sources influencing the formation of these perceptions (Finson, 2002; Miller, DI, Nolla, Eagly & Uttal, 2018; Yacoubian, Al-Khatib & Mardirossian, 2017). In line with these research topics, it is evident that both science and social studies courses address content related to science and scientists, therefore, students' perceptions of scientists hold particular importance. We aimed to enhance students' interest and awareness by identifying their perspectives on science and scientists. The study was guided by the following research question: How do secondary school students perceive scientists in their mind maps?

Method

Research Design

We employed a phenomenological approach – a qualitative research design that focuses on defining, interpreting, and understanding secondary school students' perceptions of scientists. Phenomenology examines how individuals experience and interpret phenomena through their perceptions and senses (Patton, 2014). An inductive process with no intervention was followed.

Participant Group

This study was conducted during the autumn semester of the 2023–2024 academic year and involved Fifth-Grade students enrolled in a public secondary school in the city centre of Yalova, Turkey. The participant group consisted of 32 students – 18 girls and 14 boys. A purposive sampling technique was employed to select the participant group, based on specific predetermined criteria (Patton, 2014). The criteria included attending a school with a medium socio-economic status, being in the Fifth Grade, and ensuring a heterogeneous gender distribution (female-male balance). Fifth-Grade students were deemed appropriate participants for this study, as they are at the onset of lower secondary education – a developmental stage characterised by rapid cognitive growth and heightened receptivity to creative thinking (Craft, 2005; Torrance, 1966). Furthermore, their conceptualisation of scientist is still in the formative phase (Chambers, 1983; Finson, 2002), making this group particularly relevant for exploring emerging perceptions.

Data Collection Tools

Two data collection tools were used in this study. The first was the mind map, a tool that enables students to express their opinions and thoughts about a concept or subject (Buzan & Buzan, 2007). In this context, students were asked the question, “What are your thoughts about scientists?” and they were instructed to express their responses by creating a mind map. The second data collection tool was a set of semi-structured interviews conducted using interview forms. These forms helped identify the students’ sources of information and allowed them to express their thoughts in greater detail. Prior to implementation, two field experts and a teacher reviewed the data collection tools to ensure content validity, clarity of meaning, and language accuracy. Additionally, ethical approval for the study was obtained from the Research Ethics Committee of Van Yüzüncü Yıl University. Within the scope of the research, ethical approval was obtained from the

Social and Human Sciences Publication Ethics Committee Chairmanship of Van Yüzüncü Yıl University, dated 23/08/2023 and numbered 2023/22-09.

Data Analysis

The data obtained from mind maps and structured interview responses were analysed using content analysis. To begin the process, we examined students’ mind maps and their responses related to the concept “scientist.” Subsequently, we coded the data systematically, following a structured sequence (Saldaña, 2025).

Validity and Reliability

Research validity was ensured through triangulation, adopting an interpretive perspective. To achieve this, multiple researchers independently compared, interpreted, and verified the data from their respective perspectives. To ensure reliability, detailed documentation of data collection and analysis procedures was maintained in accordance with the audit trail technique (Merriam, 2009). Furthermore, to enhance inter-coder reliability, we consulted academic experts affiliated with accredited universities (Silverman, 2005). Volunteer students actively participated in all stages of the study. To prevent data loss and confusion, we anonymised and coded the student data using identifiers such as S1, S2, and S3.

Findings

Scientist in Secondary School Students’ Mind Maps and Drawings

In the first phase of the study, we analysed the mind maps created by the participants on the concept of scientist and the attributes they associated with scientists. Subsequently, these mind maps were evaluated using visual analysis techniques, and general interpretations were made based on their content. The students’ illustrations of scientists were presented in the form of figures and interpreted accordingly.

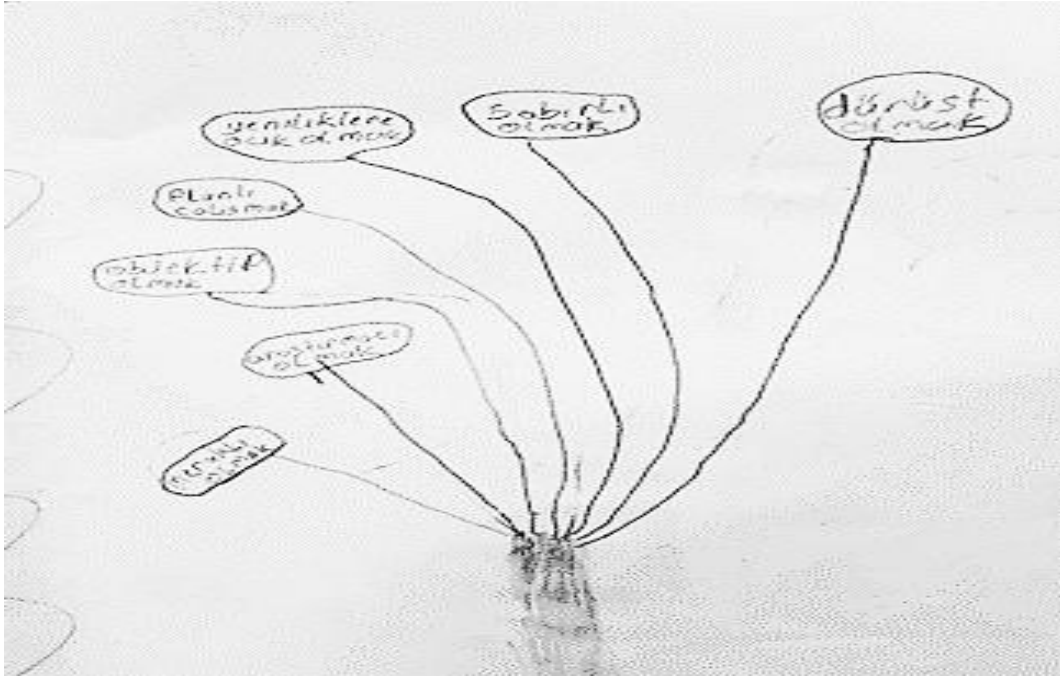


Figure 2 Drawing by S11

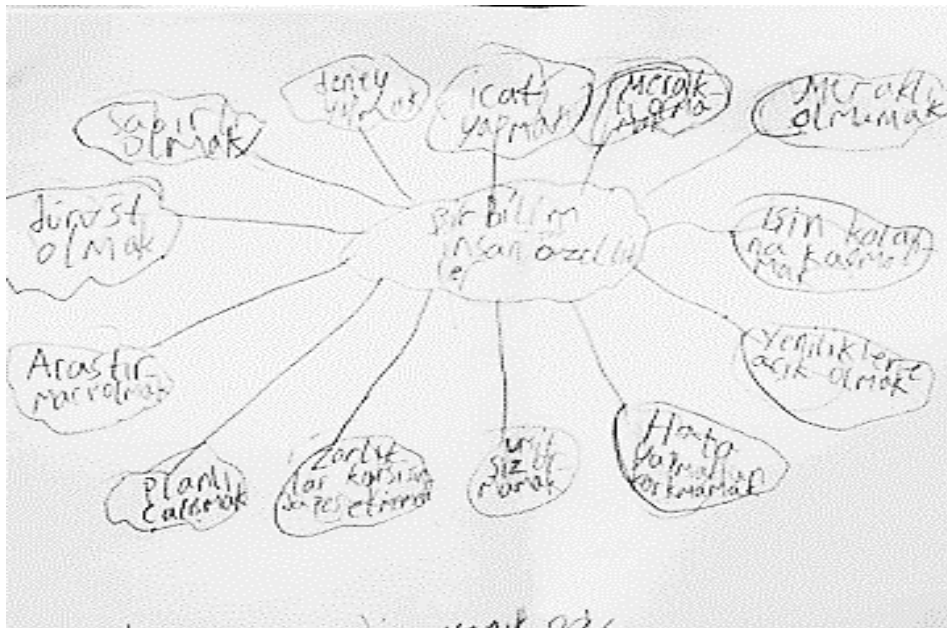


Figure 3 Drawing by S6

Figure 2 represents the mind map created by S11. The written expressions included in the drawing describe a scientist as curious, investigative, objective, organised, open to innovation, patient, and honest. Figure 3 displays the mind map created by S6. In this illustration, the

characteristics attributed to scientists are honesty, patience, experimental, inventive, curious, diligent (not inclined to take shortcuts), open to innovation, unafraid of making mistakes, hopeful, persistent in the face of challenges, methodical, and investigative.

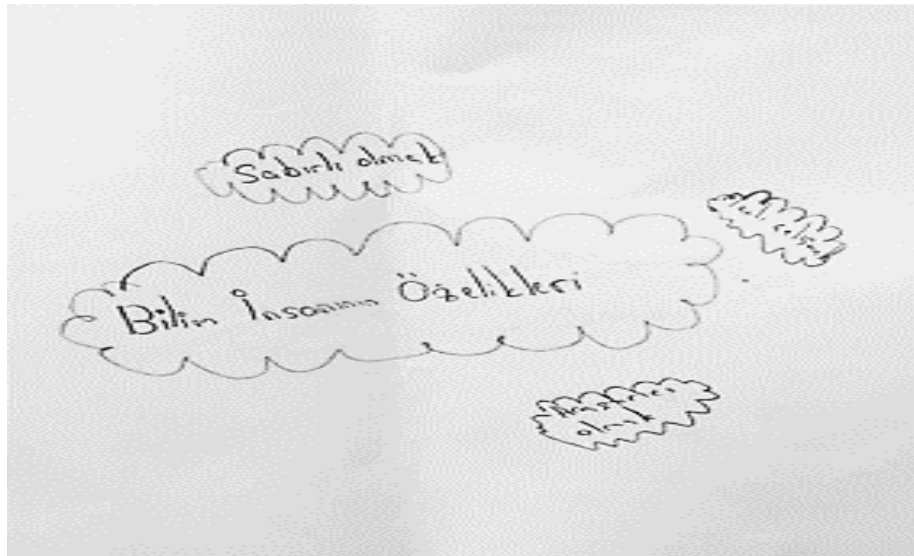


Figure 4 Drawing by S8

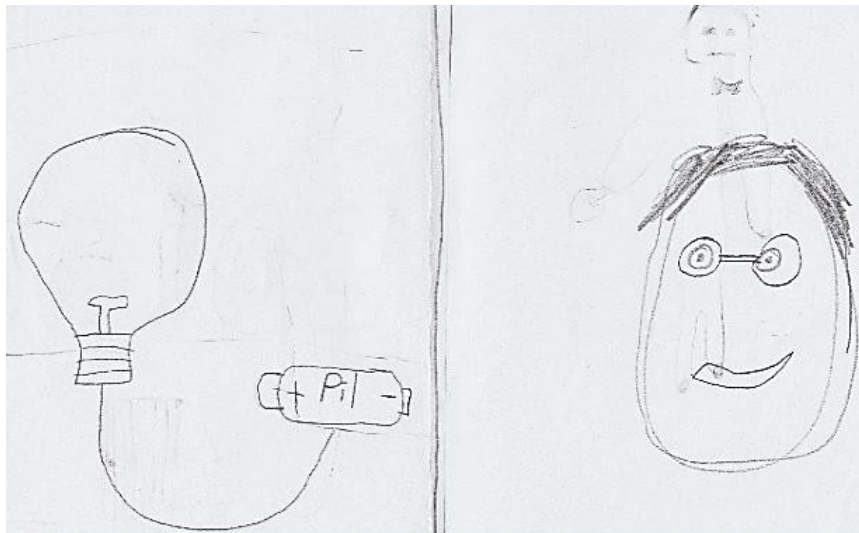


Figure 5 Drawing by S7

Student 8 (S8) described a scientist as patient, hardworking, and investigative (Figure 4). Figure 5 illustrates a depiction of a scientist by S7. The

drawing includes symbols such as a light bulb and a battery, as well as a figure with an egg-shaped head, wearing glasses and a suit.

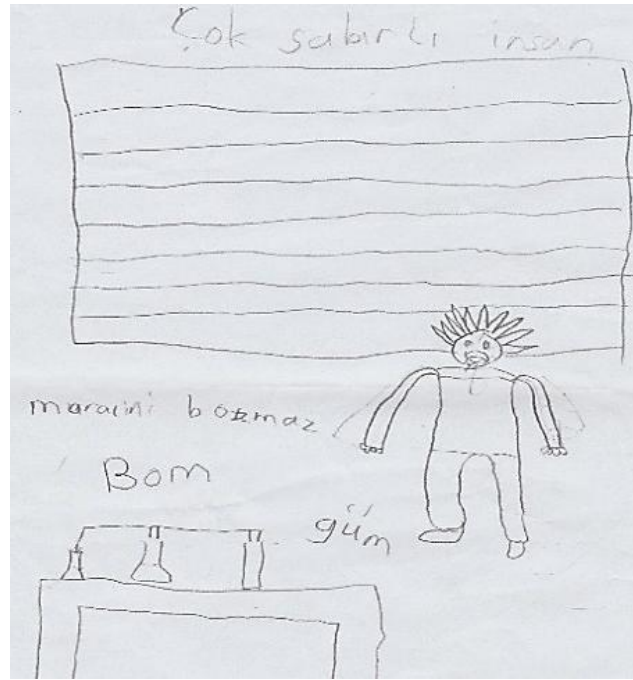


Figure 6 Drawing by S10

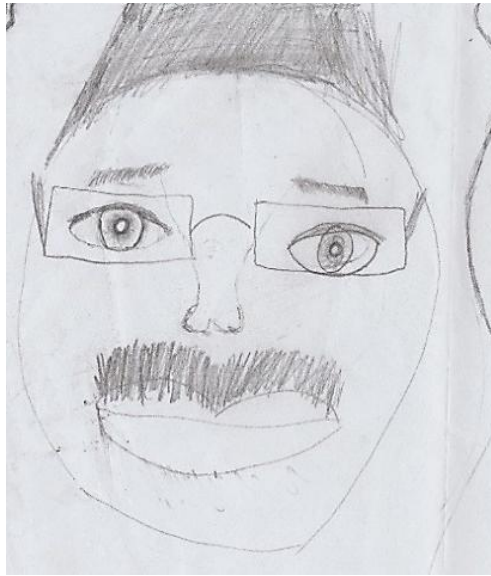


Figure 7 Drawing by S8

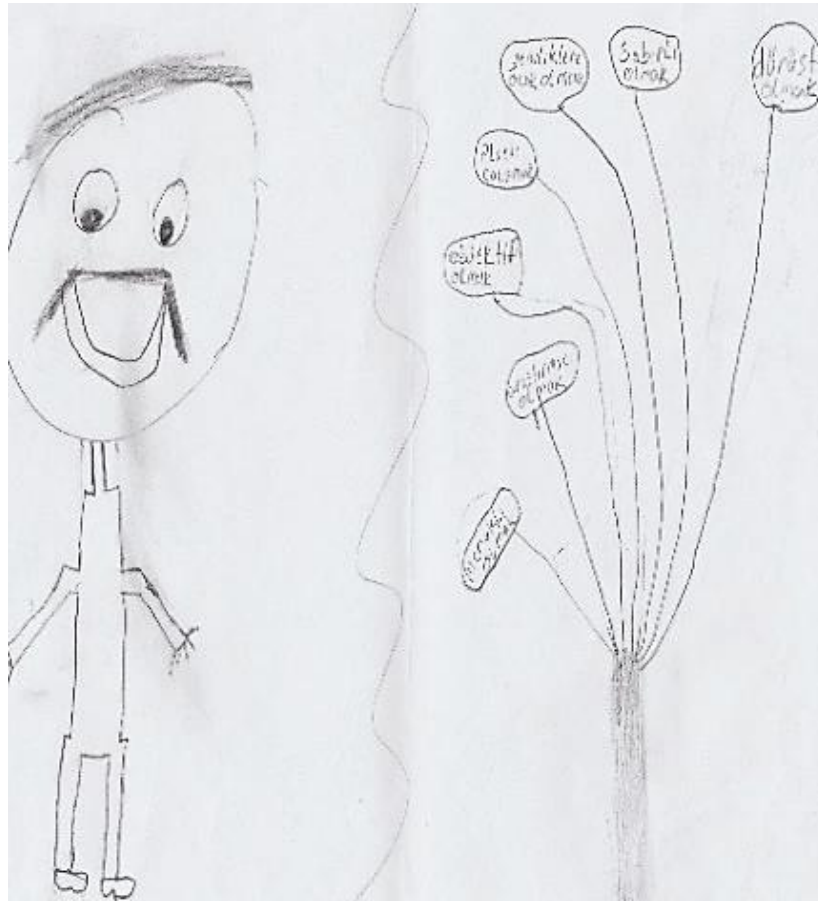


Figure 8 Drawing by S5

The mind map drawn by S10 depicts a laboratory setting where a scientist is represented wearing a mask and protective clothing, alongside a laboratory table with test tubes (Figure 6). In Figure 7 a scientist is portrayed in the student's

mental image as a male figure characterised by glasses, a prominent moustache, and short hair. In Figure 8, a tree metaphor was used to symbolise the characteristics of a male scientist with a moustache.

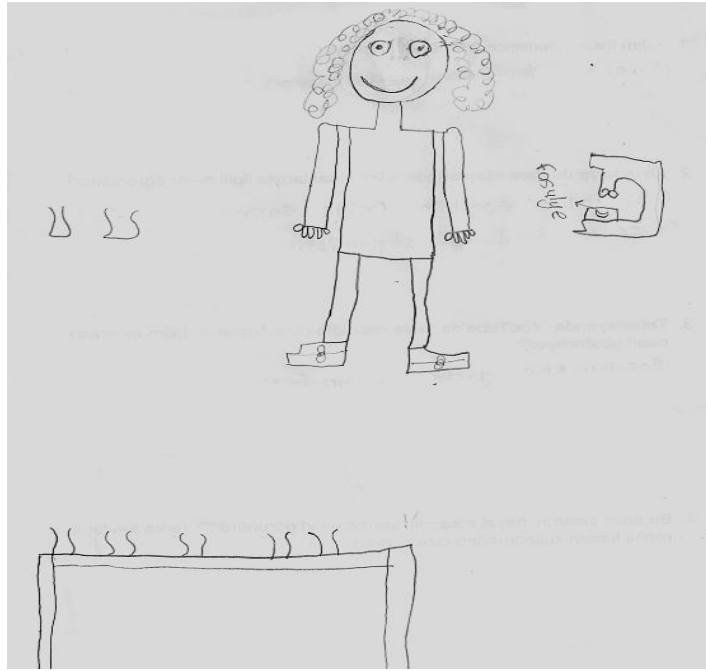


Figure 9 Drawing by S13



Figure 10 Drawing by S15

In Figure 9, the figure features long hair, a dress, and distinct facial features. From a formal analysis perspective, the body structure is simple and consistent with the schematic drawing stage typical of children. The torso is rendered as a rectangle, while the arms and legs are depicted with thin lines. The detailed depiction of curly hair suggests that the student conceived the figure as a female scientist. Portraying the figure as a woman indicates that traditional stereotypes regarding scientists are beginning to shift in the perceptions of some students. Contrary to the commonly

referenced stereotype in the literature, namely, the assumption that scientists are male, this drawing reflects an emerging awareness that women also participate in scientific production. Similar findings apply to the drawing in Figure 10. From a semiotic perspective, the smiling facial expression indicates that the student attributes positive meanings to a scientist. The inclusion of a dress and long hair reflects the influence of gender norms on the drawing. Additionally, the objects placed beside the figure (such as a symbolic device or shape) evoke associations with scientific work.

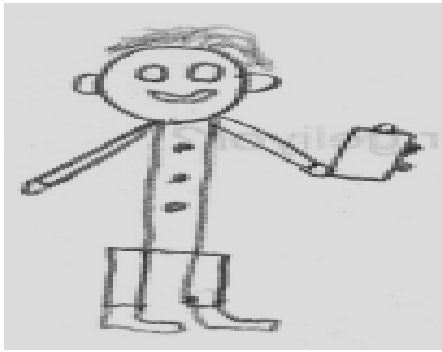


Figure 11 Drawing by S16

In Figure 11, the figure is depicted holding a device (likely a tablet, clipboard, or technical instrument) and wearing a long coat with button-like markings. A formal analysis of this figure indicates that the student represents the scientist like a laboratory worker (long white coat, buttons, and a handheld technical tool). The technological object held in the figure's hand reflects the student's perception that science is not solely theoretical, but also an experimental and instrument-supported activity. This suggests that students tend to equate



Figure 12 Drawing by S17

scientific work with the use of contemporary technological tools. The long lab coat appears to symbolise scientific authority, while the device held in the figure's hand conveys the notion of a dependence on scientific instruments. The smile on the figure's face serves as an indicator positioning science as a positive and accessible professional field. Similarly, in Figure 12, the student demonstrated a strong association between the scientist and technology.



Figure 13 Drawing by S19

In Figures 13 and 14, the figures are depicted with glasses, short hair, and casual clothing. From a formal perspective, the drawings present a proportionate human figure with characteristic features. The glasses are among the most prominent elements of the depiction and directly reference common scientist stereotypes. The use of glasses suggests that the student views scientists as people who read, research, and work intensively. This aligns with findings in the literature indicating that the stereotypical image of a scientist with glasses is frequently internalised by students. Since glasses are



Figure 14 Drawing by S21

symbolically associated with intelligence and academic effort, the drawings imply that the students connected this symbol with the cognitive demands of scientific work. Furthermore, the student's choice to portray the scientist in regular clothing rather than a lab coat indicates a broader perception – one that does not confine scientists solely to laboratory settings. Therefore, as shown in Figures 13 and 14, some students continued to reproduce the stereotype of a scientist with glasses, however, these students may also hold a more flexible perspective that integrates scientists into everyday life.

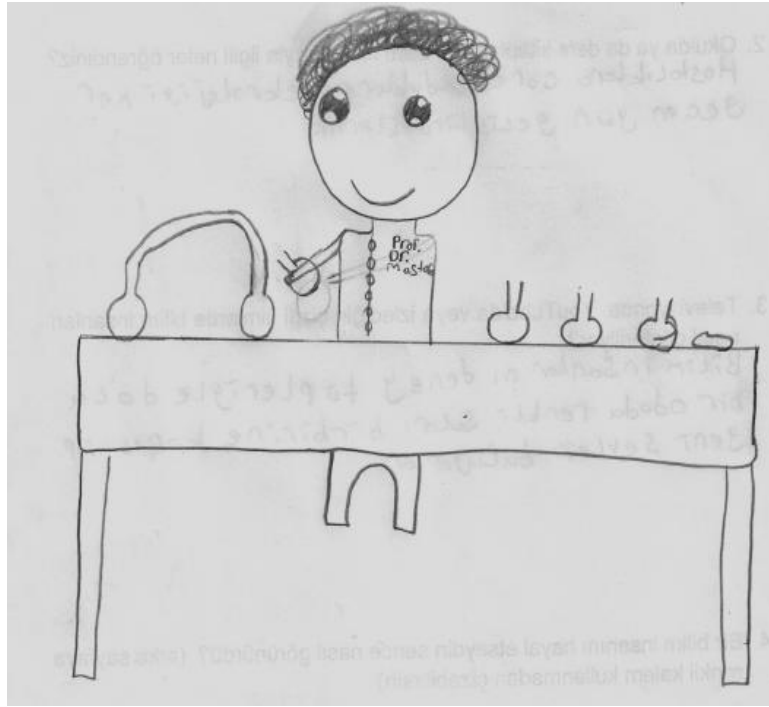


Figure 15 Drawing by S22

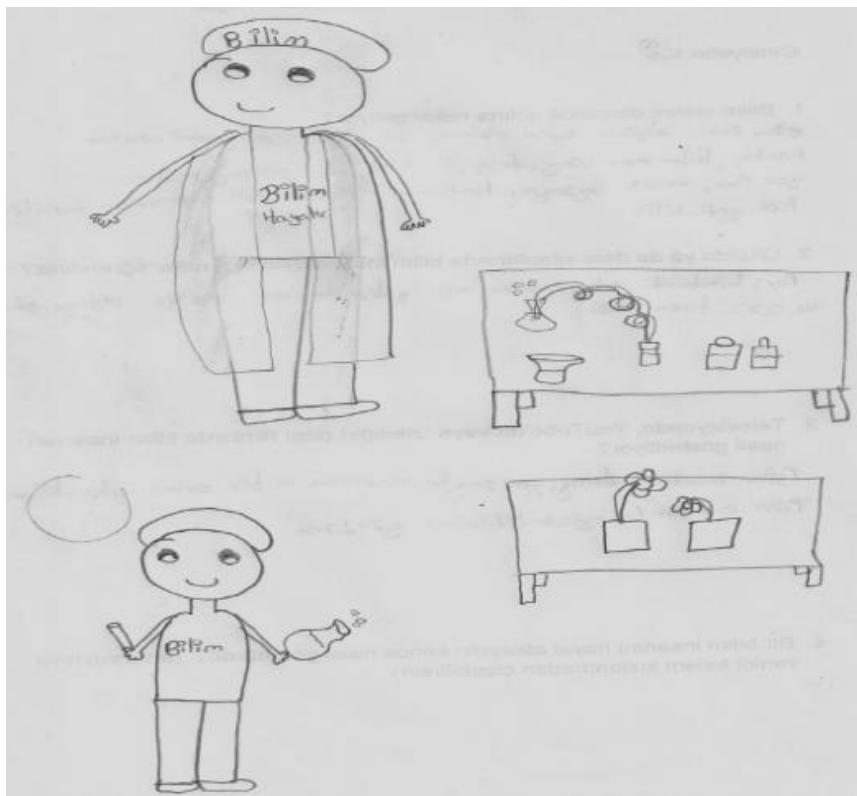


Figure 16 Drawing by S26

In Figure 15, a large table, glass containers resembling laboratory equipment, and various experimental tools are depicted. The figure stands behind the table, with a clearly defined facial expression and a human form constructed from

simple geometric shapes (a round head, stick-like arms, etc.), which are typical of children's drawings. The presence of an academic label such as "Prof Dr." on the figure indicates that the child conceptualises a scientist through status and

academic title. This drawing suggests that the student perceives a scientist primarily as someone who conducts experiments in a laboratory setting. The laboratory setup on the table (flasks, tubes, liquids) shows that scientific activities are largely associated with chemistry. The student envisions a scientist as a technically knowledgeable individual with an academic title who works in an experiment-oriented manner. Overall, the drawing reveals that the child perceives scientific work as a

tool-intensive process carried out at a workstation within a controlled environment. In Figure 16, the figure is rendered from multiple perspectives, indicating that the student conceived the scientist holistically – both as an individual and in relation to their working environment. The systematic depiction of laboratory tables and the repeated presence of tubes and containers further supports the notion that the student perceived scientific work as a tool-based and technical activity.

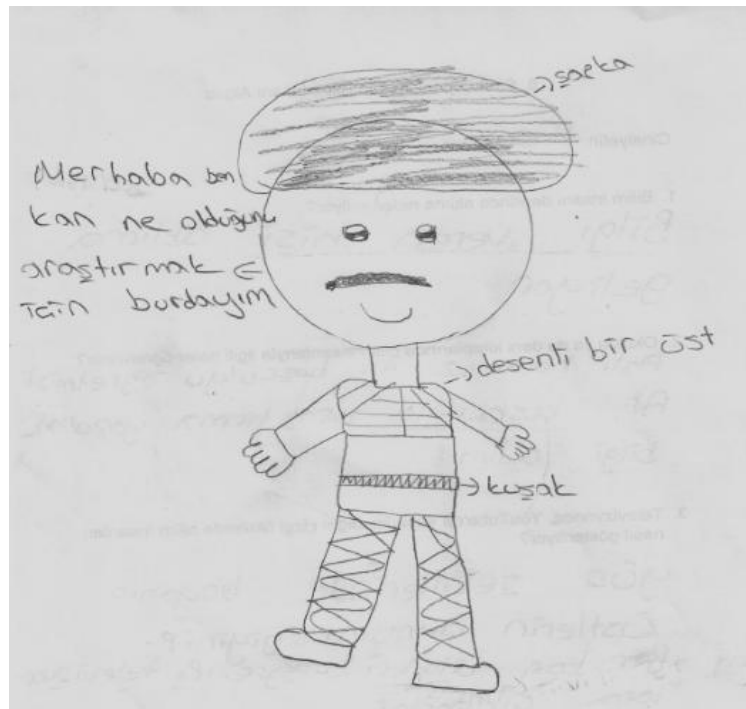


Figure 17 Drawing by S27

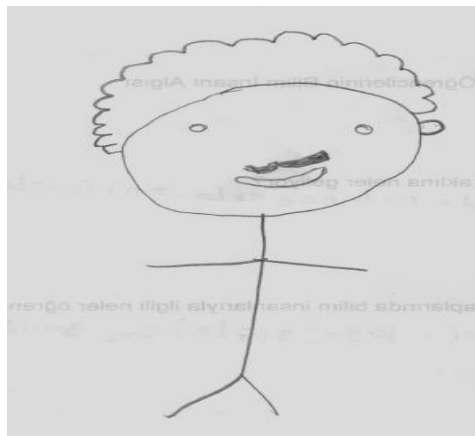


Figure 18 Drawing by S29

Figure 17 contains explanatory notes: “*hat, patterned top, belt.*” The figure is depicted wearing more traditional clothing. The moustache drawn on the face conveys an impression of adulthood and authority compared with the other drawings. The text in the drawing – “*Hello, I am here to investigate*

what blood is” – reveals that the student viewed the scientist as a researcher who asks questions and works to gather information on a specific topic. The choice of clothing indicates that a scientist is not necessarily imagined as someone who always wears a lab coat. The child rather envisioned a scientist as

someone who can be represented through different identities. This may reflect a conscious or unconscious awareness that scientists are not distinguished from ordinary members of society by attire, but by the act of conducting research. In this drawing, the act of investigation is placed at the centre of the image, and the scientist is represented with a simpler, more personal identity. The presence of a moustache on the figure supports the idea that

the student perceives scientists as adult male individuals.

The mind maps and drawings created by the 32 students who participated in the study revealed various sub-concepts related to the concept “scientist.” These sub-concepts were identified using coding techniques suitable for qualitative data analysis. The frequency distributions of the codes obtained are presented in detail in Figure 19.

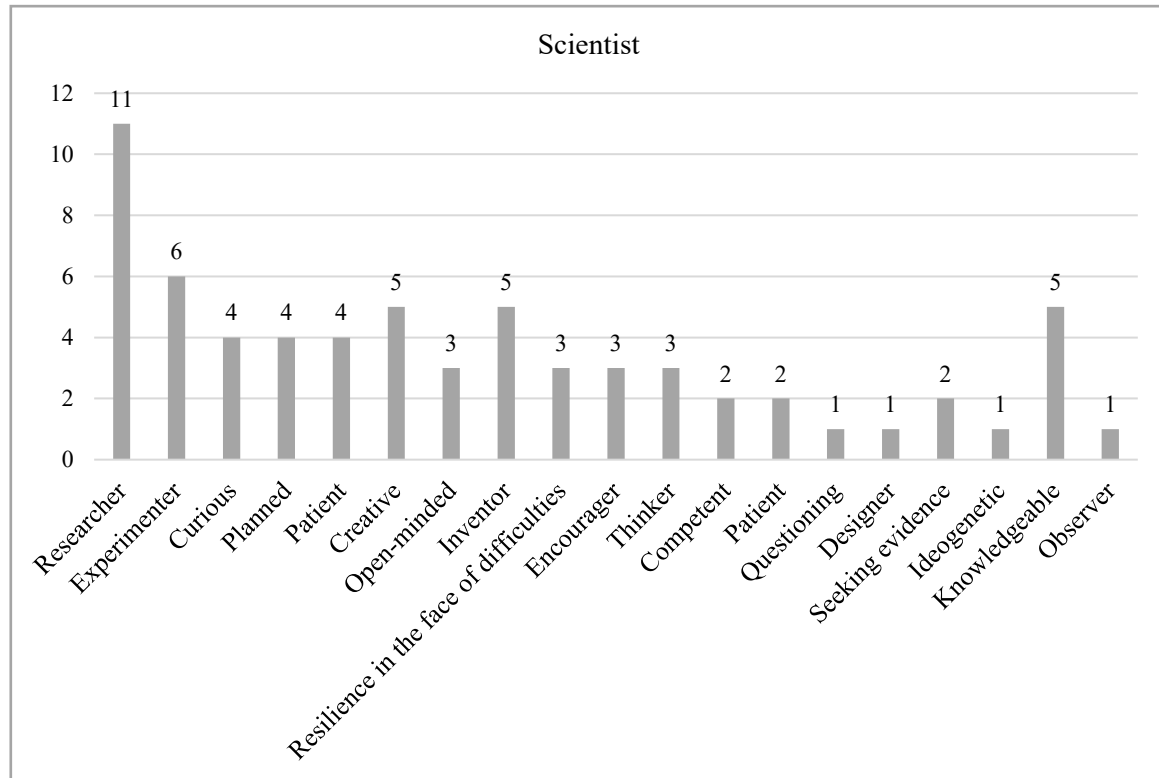


Figure 19 Attributes of scientists in students' mind maps

An analysis of Figure 19 reveals that participants described scientists as researcher, experimenter, creative, inventor, and knowledgeable. Overall, these descriptors reflect entirely positive perceptions. Students who responded to open-ended questions stated that their ideas about scientists were primarily shaped by knowledge gained through school, books, and media sources. Some students also indicated that they had acquired this information through research assignments.

Scientists in School Contexts and Social Studies Textbooks

In this section we present statements reflecting the knowledge that students acquire about scientists within the school environment, particularly in the context of the social studies course. These findings offer important insight into how students position scientists, which aspects of scientific processes they focus on, and how the instructional context shapes their perceptions.

Table 1 Students' knowledge about scientists gained in school and through the social studies textbooks

Student statement	<i>f</i>
They research important things and provide us with information	7
Inventions that make human life easier	5
Broad imagination	5
Extremely intelligent	4
Finding cures for diseases	2
Developing new things every day	2
Robot dog, kitchen robot	2
Ali Kuşçu	1
Galileo's Sun theory	1
Going to the moon and determining the number of craters	1
Fault lines	1
Scientists feeling dizzy when they return to Earth due to the moon's atmosphere	1

The data obtained from Fifth-Grade students, presented in Table 1, indicate that students primarily define a scientist as “*a person who investigates important issues and provides information to society.*” Statements with higher frequency reveal that a scientist is idealised as someone who invents things that make human life easier, possesses a broad imagination, and is extremely intelligent. However, students often associate scientists with popular and science-centred themes such as technology, robotics, space, and curing diseases. This suggests that students may not fully recognise the broader dimensions of science, including systematic thinking, analytical processes, and research conducted within social contexts. The mention of historical figures such as Ali Kuşçu and Galileo reflects the influence of the social studies

curriculum, yet the overall perception of a scientist still appears to be shaped largely by an idealised and stereotypical framework – one in which the scientist is portrayed as “*a highly intelligent individual who is constantly inventing new things.*” Overall, the findings show that while students define scientists in positive terms, they often equate this figure with a narrow and idealised role.

Students' Views on the Portrayal of Scientists in Media (Television [TV], YouTube, Cartoons)

Today, students' perceptions of scientists are significantly influenced by representations presented on media platforms like YouTube, in animated cartoons and on television. In this section we present the students' views on how scientists are depicted in these media environments.

Table 2 Students' views on scientists in the media

Categories	Codes	Examples from student statements
1) Work environment	- laboratory setting - conducting experiments - working with computers	<i>They show lots of computers in the room where the scientists are.</i> <i>They mix colourful liquids in rooms with test tubes to discover something.</i>
2) Productivity	- discovering new things - inventing - research and effort to reach a conclusion	<i>They make a great effort to reach a result.</i> <i>Invention.</i>
3) Physical appearance	- white lab coat - glasses - short stature - special clothing - devices worn on the head	<i>Short, wearing a white coat and glasses.</i> <i>Special outfit.</i> <i>They wear something on their heads.</i>
4) Media elements	- three-dimensional animation - unrealistic depictions	<i>It's not shown realistically; it's animated.</i> <i>There is 3D [three-dimensional].</i>
5) Fictional mental schema	- mad scientist - being shown as a good character	<i>A crazy man – a good man.</i>
6) Technological development	- development of technology - association with space and science	<i>Development of technology.</i> <i>Space science.</i>
7) Historical/Cultural connections	- historical figures perceived as scientists	<i>Mimar Sinan in Galata.</i>

An examination of the responses from Fifth-Grade students in Table 2 reveals that the image of scientists presented in the media is largely shaped around individuals working in laboratory settings, conducting experiments, and using technological tools such as computers. Students primarily described scientists as wearing white lab

coats, glasses, and various accessories, and they noted that media content often portrayed these figures as animated or exaggerated mad scientist characters. In addition, some students perceived scientists as individuals who invent new things, make discoveries, and exert significant effort to reach conclusions, associating scientific work with

technological advancement and space-related themes. A smaller number of students offered a broader perspective by linking historical figures – such as Mimar Sinan – to the concept of scientist. Overall, these findings suggest that students are strongly influenced by media representations and that their perceptions of scientists are shaped largely through visual and fictional portrayals.

Visual Evaluation of the Mind Maps in Student Drawings

The visual elements in students' mind maps include both figurative components (such as facial features, glasses, and moustaches) and conceptual symbols (such as light bulbs, batteries, and thought clouds). For instance, Figures 7, 17 and 18 include a male featuring glasses, a prominent moustache, and short hair. From a technical point of view, the proportional rendering of the face aligns with the expected motor skills level of primary and lower secondary school students. In Figure 5, the visual elements include symbols such as a light bulb and a battery, alongside a male figure with an egg-shaped head, glasses, and a suit. The depiction of an electrical circuit in this mind map is particularly noteworthy, as it symbolically represents scientists' connection to scientific thinking and innovation. In many of the mind maps drawn by students, text clouds were used, and in some cases, the phrase "*characteristics of a scientist*" was placed at the centre of the composition, serving as the conceptual anchor. Details such as glasses, a moustache, a suit, and hairstyle evoke the traditional image of an older male scientist. The inclusion of a battery and light bulb indicates that the perception of scientists is closely associated with physical inventions and discoveries in electricity, reflecting a science-centred viewpoint. The presence of cloud-shaped forms in the mind map suggests that the student was attempting to visualise abstract

concepts and symbolise connections between different ideas. Finally, the tree metaphor depicted in Figure 8 symbolises the growth of knowledge and values. In this context, the student conceptualised the scientist's characteristic traits as branches nourished by a common root system. The scientist figure is portrayed as a simple and content individual, thereby conveying a positive image. The branching of concepts, resembling the structure of a tree, indicates the student's ability to establish mental associations among abstract ideas. The branches extending from the centre represent the qualities that a scientist is expected to possess.

In the visual data obtained in our study, a scientist is predominantly depicted as a serious, older, male figure, often wearing glasses. This reflects how gender roles and representations in popular culture influence students' perceptions of scientists. The use of an electrical circuit indicates the student's association of science primarily with the field of physical sciences. Moreover, in some drawings, even the depiction of negative outcomes – such as explosions resulting from experiments – did not appear to affect the scientist's emotional state, suggesting that students associate patience and emotional resilience with the scientific process. This indicates that the student's understanding of a scientist encompassed not only cognitive but also affective dimensions of the scientific character. The use of onomatopoeic expressions such as "*boom*" and "*bang*" can be interpreted as a form of creative expression. The student emphasised that the scientific process involves errors and highlighted the importance of patience as an integral part of that process. A scientist is portrayed not merely as a producer of knowledge, but also as a figure with moral and intellectual qualities, such as being "*patient*", "*hardworking*", "*intelligent*" and "*inquisitive*." Further explanations of these concepts are provided in Table 3.

Table 3 Definition of conceptual symbols and their meanings

Symbol	Meaning	Explanation
Glasses	Wisdom, reading, observation	A scientist is perceived as someone who reads and observes attentively.
Light bulb	Idea, invention	A metaphor for “creativity” and “enlightenment.” Creativity is a core trait of a scientist.
Battery	Energy, experimentation	Associated with materials used in scientific experiments.
Laboratory table	Experimental environment, systematic observation	A scientist is concretised as someone engaged in experimental work. This reflects the student’s attempt at visualising the scientific process.
Test tube	Chemical reaction, laboratory work	The student associates science with chemistry experiments. The test tube is linked to processes of discovery and observation.
Oxygen mask	Safety, health, laboratory conditions	The student developed a perception of a scientist as someone who is aware of the risks in experimental environments and takes appropriate precautions. A scientist is conceptualised as a responsible individual.
Laboratory	Scientific environment, site of knowledge production	A scientist is positioned as an individual working in a specialised, well-equipped setting. The associated visual reinforces perceptions of professionalism and disciplined work.
Moustache	Maturity, age, culture	A scientist figure is symbolised as an elderly male, and the moustache reflects cultural elements associated with this perception.
Mind map clouds	Conceptual framework	The student categorised ideas visually, demonstrating an effort to conceptualise their thoughts.
Tree branches	Conceptual expansion and mental connections	The outward flow of ideas from the centre represents the student’s attempt at systematic thinking and organising ideas.

Table 3 presents the symbols and meanings derived from students’ responses regarding the concept “scientist.” In some girls’ and boys’ drawings, scientists are depicted only as male. This reflects the persistence of gender stereotypes in representations of scientific professions. Based on the students’ illustrations, it is possible to interpret their perception of scientists across six fundamental dimensions (Kress & Van Leeuwen, 2020; Rose, 2022; Sarikaya, 2017).

- 1) Visual patterns: The student drawings predominantly feature male figures with glasses and moustaches, highlighting the influence of visual stereotypes likely shaped by media, cultural norms, and school materials. Illustrations such as test tubes and laboratory tables suggest that students’ perceptions of scientists are frequently confined to physical sciences, particularly experimental procedures and laboratory settings. These symbols reinforce the notion of scientists operating in technical and systematic environments. Moreover, the inclusion of details such as an oxygen mask indicates that students can relate not only to scientific content but also to contextual factors such as safety in laboratory conditions.
- 2) Conceptual dimension: The students emphasised the importance of personal traits for scientific success, highlighting virtues such as patience, inquisitiveness, and intelligence. Symbols like the laboratory table and experimental equipment suggest that students perceived science not merely as theoretical knowledge but as a hands-on, experiential process. In this context, it becomes evident that students do not conceptualise the notion of a scientist solely in abstract terms, but also situate it within a tangible, physical environment.
- 3) Symbolic thinking: The drawing of an electrical circuit illustrates the association of science with applied and mechanical metaphors, indicating student preference for visual-auditory modes of

learning. A test tube is a symbol commonly associated with science in modern culture. The inclusion of such elements in students’ mind maps suggests that their perceptions of science is shaped through images embedded in collective social memory. The visual text is supported by iconic symbols such as glasses, light bulbs, test tubes, and similar elements. A classic mind map structure is present, featuring cloud-shaped frames to arrange and display concepts. The concepts are expressed in a clear and concrete manner. The light bulb and battery can be interpreted as representations of technical knowledge. Similarly, glasses are associated with the scientific figure.

- 4) Structure of the mind map: The branching structure from the centre, combined with conceptual groupings, is arranged in a way that reflects a balance between abstract and concrete elements.
- 5) Semantic interpretation: The student appears to perceive scientists not merely as professional figures, but as individuals who possess moral, cognitive, and personal virtues. The inclusion of abstract traits such as “being patient” and “being inquisitive” suggests a certain level of conceptual maturity. The drawings indicate that the students associated scientists not only with technical knowledge, but also positioned them as friendly, creative, and imaginative. Accordingly, the light bulb symbol is widely recognised as a representation of knowledge, invention, and enlightenment (Lakoff & Johnson, 1980). In particular, the conceptualisation of the laboratory as a workspace reflects the child’s ability to form a connection between space and scientific knowledge.

Evaluation of Students’ Mind Maps by Gender and Age Characteristics

The perceptions of middle school students regarding scientists were compared based on gender- and age-related variables, leading to several key findings. These findings are presented in Table 4.

Table 4 Comparison of students' perceptions of scientists based on gender and age

Conceptual theme	Age 10	Age 10	Age 11	Age 11	Total	Total	Total
	Male	Female	Male	Female	Male	Female	
Being patient	4	3	2	1	6	4	10
Conducting research/Being inquisitive	3	4	1	2	4	6	10
Being curious	2	1	1	2	3	3	6
Being honest/Truthful	4	1	1	2	5	3	8
Conducting experiments	2	1	2	2	4	3	7
Being open to innovation/Innovative	2	1	1	0	3	1	4
Planned	2	0	0	1	2	1	3
Being sceptical	0	1	1	1	1	2	3
Being hardworking	1	1	1	0	2	1	3
Inventing/Being an inventor	1	1	1	0	2	1	3
Being objective	0	2	1	0	1	2	3
Designing/Generating ideas	1	0	0	2	1	2	3
Being hopeful/Having belief	1	1	1	0	2	1	3
Being questioning/Seeking evidence	0	0	0	2	0	2	2
Being an expert/Scholar	0	0	2	0	2	0	2
Leadership/Being a leader	0	1	0	1	0	2	2
Making observations	0	0	1	1	1	1	2
Being determined/Persistent	0	0	1	1	1	1	2
Physical characteristics	0	0	1	0	1	0	1
Resilience in the face of difficulties	2	0	0	0	2	0	2

- 1) Gender-based comparison: In the study, female students tended to describe scientists using more cognitive and intellectual traits, such as being inquisitive, reflective, idea-generating, objective, and detail-oriented. In contrast, male students were more inclined to define scientists through practical and external attributes, such as being creative, conducting experiments, strong, expert, and physical appearance (e.g., wearing glasses). A noteworthy finding is that higher-order thinking skills such as observation, design, and idea generation were expressed exclusively by female students.
- 2) Age-based comparison: Students in the 10-year-old age group primarily focused on basic scientific process skills when describing scientists, emphasising traits such as curiosity, patience, research, and conducting experiments. In contrast, the 11-year-old group described scientists using more holistic, systematic, and abstract attributes, including scepticism, expertise, attention to detail, and productivity. This distinction aligns with well-established theories of cognitive development. Some of the prominent concepts in the 11-year-old age group included more complex cognitive structures such as being sceptical, detail-oriented, productive, design-oriented, idea-generating, observant, determined, and being a leader.
- 3) Common and unique attributes: Among the common attributes, patience, research, curiosity, conducting experiments, honesty, and creativity emerged as recurring values across nearly all age and gender

groups. This suggests that students associated the image of scientists with both moral virtues (e.g., honesty, diligence, perseverance) and academic competencies (e.g., experimentation, invention, inquiry). In contrast, unique traits such as wearing glasses (appearance-based imagery), leadership, attention to detail, scepticism, and stubbornness were expressed by only a limited number of students, reflecting more personalised or distinctive perceptions.

- 4) Association with the Social Studies Course: A significant portion of the students' expressions of scientists in their mind maps aligned with the core life skills emphasised in the Social Studies Curriculum such as questioning, researching, generating knowledge, and contributing to societal benefit. This finding indicates that the course is not limited to historical or social content but also supports creative and scientific thinking.

Codes and Themes Developed for the Characteristics of Scientists

In the study, we categorised the characteristics of scientists into specific codes and themes based on student responses. The findings reveal five key themes in students' perceptions of scientists: creativity skills, success discipline, philosophical aspect, physical characteristics, and personality traits.

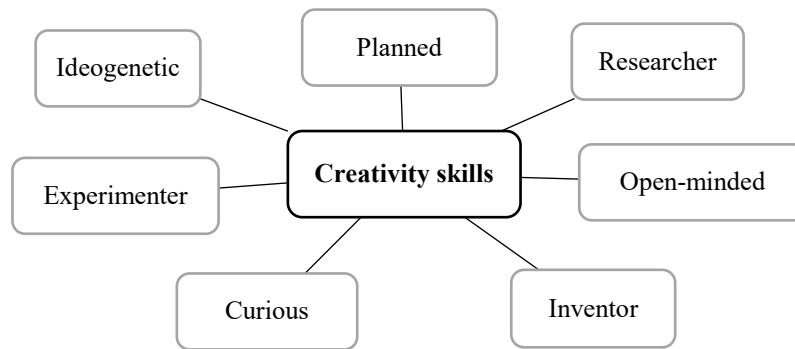


Figure 20 Creativity skills

In Figure 20, the first theme identified for scientists is creativity skills. Under this theme, a scientist is described as someone who is ideogenetic, works in a planned manner, conducts research, is

open-minded, has a penchant for experimentation and invention, and is curious. The codes within this theme reflect scientists' positive and productive nature.

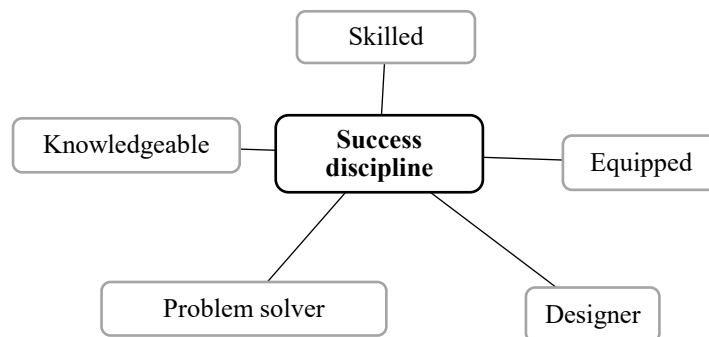


Figure 21 Success discipline

The second theme identified for scientists is success discipline (Figure 21). In this theme a scientist is portrayed as a knowledgeable, skilled, and well-equipped designer and problem solver. An analysis of the students' statements suggests that scientists were perceived as being one step ahead of

society. However, the most notable criticism related to this theme was that students struggled generating deeper or more comprehensive ideas. Therefore, while students generally held a positive perception of scientists, their understanding tended to be limited to certain predefined concepts.

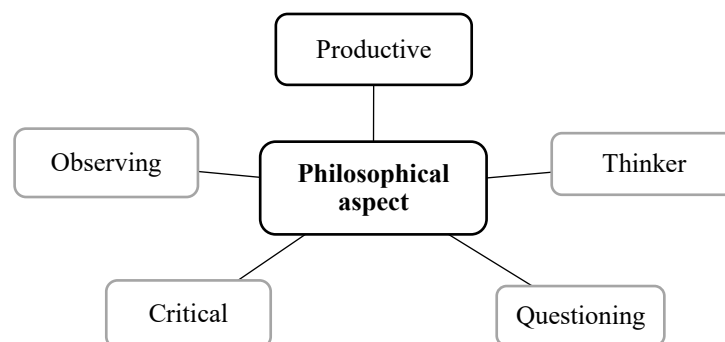


Figure 22 Philosophical aspect

The third theme refers to the philosophical aspect (Figure 22). In this theme scientists observe,

are productive, thinkers, questioning, and critical.

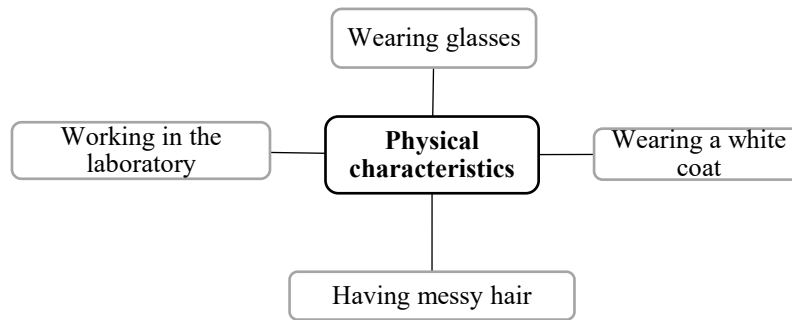


Figure 23 Physical characteristics

The fourth theme is physical characteristics (Figure 23). In this theme a scientist is someone who

works in a laboratory, wears glasses and a white coat, and has messy hair.

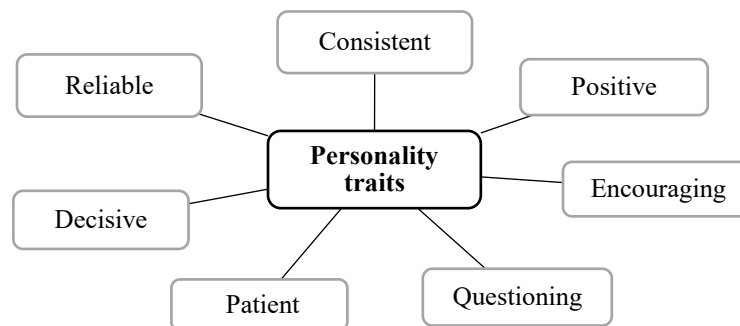


Figure 24 Personality traits

As shown in Figure 24, the third prominent theme related to scientists' personality traits. The codes in this theme include traits such as being reliable, consistent, and positive, as well as

promoting questioning, patience, and determination.

The conceptual model encompassing all themes and secondary school students' perceptions of scientists is presented in Figure 25.

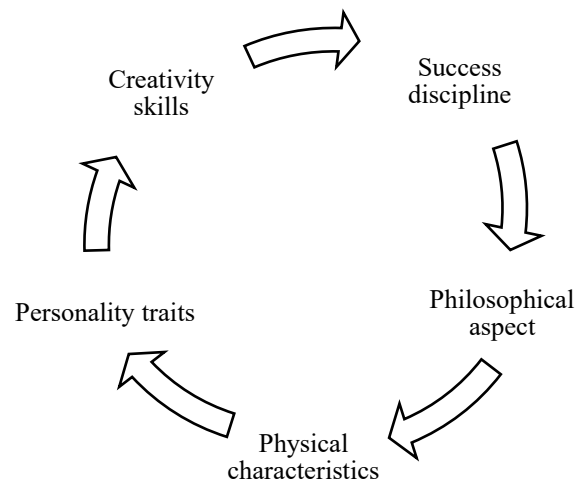


Figure 25 Creative model on perceptions about scientists

Discussion

In this study we aimed to explore middle school students' perceptions of scientists using mind maps. Students' conceptual representations predominantly focused on the character traits and creative capacities of scientists. The scientist figure was

often portrayed with positive attributes such as being inquisitive, experimental, curious, and patient. The physical image of a scientist was frequently described as a male working in an enclosed space, engaging with test tubes, wearing glasses, and having a moustache – indicating an implicit

gendered representation. These findings show similarities with previous research conducted in different countries regarding elementary and middle school students' perceptions of scientists. For instance, in the study by Bartoszeck and Bartoszeck (2017), Brazilian students described scientists as male individuals working alone in laboratories, wearing lab coats and glasses. Students in Poland (Bernard & Dudek, 2017) and the United Arab Emirates (Dickson & McMinn, 2022) portrayed scientists as individuals who wear white lab coats, use glasses, and work in laboratory environments. Native American students also depicted scientists as individuals who mix or test chemicals (Laubach, Crofford & Marek, 2012). Similarly, among Lebanese students, the image of a scientist was often stereotyped as a white male working in a laboratory setting, primarily engaging in chemical experiments (El Takach & Yacoubian, 2020). In studies conducted by Emvalotis and Koutsianou (2018), and Samaras, Bonoti and Christidou (2012), Greek students also associated scientists predominantly with laboratory-based experimentation. In a study by Leavy, Hourigan and Cleary (2023), students in Ireland frequently depicted scientists as smiling men working indoors, wearing lab coats, and using chemistry equipment. Similar biased physical representations of scientists can be observed across numerous studies in the literature (Bang et al., 2014; Chambers, 1983; Miller, DI et al., 2018; Sheffield et al., 2021; Song & Kim, 1999). Furthermore, Philander (2009) defines a scientist as an individual who teaches, advises students, and conducts research that leads to scholarly publications.

In our study, the perception of scientists – differentiated by both gender and age groups – was associated with a wide range of elevated qualities and academic competencies. The emphasis on high moral values was also evident in a study conducted by Fujiwara, Jones, Hite and Velasco (2026) with Thai students. In Gonsoulin's (2001) study, male students tended to depict scientists as male figures, whereas female students represented scientists as both female and male. Some studies show that male students did not explicitly emphasise gender in their drawings (Bernard & Dudek, 2017), while both female and male students generally portraying male scientists more frequently than female scientists (Dickson & McMinn, 2022). İvgin, Akçay and Kapıcı (2021) report that middle school students perceived scientists as male individuals working alone, often referring to Albert Einstein and Isaac Newton as examples. In a study conducted in South Africa, Black women were positioned as outliers within academic institutions, marginalised from the dominant structures associated with scientists (Liccardo & Bradbury, 2017). Such gender-based stereotypes have persisted throughout history and continue to exist today (Clegg & Duncan, 1985).

These findings necessitate a reconsideration of the factors that shape students' mental representations of scientists. Indeed, students' perceptions of scientists may significantly impact their career aspirations (Odell, Hewitt, Bowman & Boone, 1993). If the stereotypical image of a scientist is perceived as a white, middle-aged male, this perception may serve as a barrier for individuals who do not conform to this stereotype from considering a career in science (Gligorić, Clerc, Arkensteijn, Van Kleef & Rutjens, 2024). Students' perceptions of scientists are influenced by factors they observe in their immediate environment, including individuals they know and concrete elements that enrich their understanding. Throughout this process, students' prior knowledge, their experiences with scientific process skills, textbooks, and the influence of society, culture, and the media may all shape or restrict their possible perceptions of scientists. Our study reveals that the mental image of a scientist held by students in Türkiye aligns conceptually with the portrayal found in officially approved social studies textbooks, but only partially aligns in terms of physical representation (MoNE, 2018). The textbook content typically presents scientists as research-oriented individuals who contribute to society, often working in laboratories, and predominantly male. In addition to figures such as Edison and Newton, there are also references to scientists from the social sciences, such as Ibn Khaldun. The findings indicate that students idealised scientists presented in school contexts, by teachers, and in textbooks as persons who invent tools that make human life easier, possesses a broad imagination, and are exceptionally intelligent. Therefore, we may argue that school materials play a significant role in shaping students' mental representations of scientists (Steinke, Lapinski, Crocker, Zietsman-Thomas, Williams, Evergreen & Kuchibhotla, 2007; Yacoubian et al., 2017). Besley, Lee and Pressgrove (2021) identified that taking science courses is also a significant determinant in shaping students' perceptions of scientists. However, students predominantly associated scientists with popular, science-centred concepts such as technology, robotics, and outer space. This suggests that students may not fully recognise the broader dimensions of science, including systematic thinking, analytical processes, and research conducted within social contexts. From the perspective of media influence, it is noteworthy that mass media, particularly television, plays a crucial role in shaping young children's mental images of scientists. The study also shows that students' views are strongly shaped by images of scientist presented in the media, which typically portrays scientists as individuals working in laboratory settings, conducting experiments, and engaging with technological devices such as computers. Students often described media representations of scientists

as wearing white lab coats, glasses, and specific accessories, and as characters depicted in exaggerated mad scientist forms. The portrayal of eccentric scientist characters in cartoons or TV shows that introduce children to science may distort and negatively shape their mental perceptions of scientists (Buldu, 2006). Moreover, from a gender-based perspective, girls grow up in a media environment saturated with images that reinforce culturally constructed norms of femininity. Although the representation of women in the media has improved in recent years, many portrayals still focus on female characters who are concerned primarily with physical appearance and romantic relationships rather than academic or professional careers (Steinke, 2005). From a cultural perspective, religious and political ideologies – varying significantly across countries – can also shape public perceptions of science and scientists differently (Koswatta, Wingenbach & Leggette, 2023). Children acquire cultural behaviour patterns by observing both real-life models in their social environment – such as parents and teachers – and symbolic models portrayed in the media (Bandura, 1969). Farland-Smith (2009) examined how culture shaped students' perceptions of scientists and found that while students in the United States of America commonly depicted scientists within the traditional setting of a chemical laboratory, Chinese students frequently included robots in their representations – highlighting how cultural frameworks inform and influence these perceptions. The depiction of male scientists with moustaches in the student drawings in our study can also be interpreted as a reflection of culturally grounded influences shaped by social learning.

Conclusion and Recommendations

The findings reveal that, within students' mental constructs, a scientist is perceived as a leading figure characterised by productivity and creativity. Scientists are regarded as exemplars through their achievements, as sources of philosophical inspiration, and as role models in terms of character, despite being associated with a stereotypical physical image. However, students' prior knowledge, experiences with scientific process skills, and the influence of society, media, and culture collectively limit their potential to form comprehensive perceptions of scientists. Factors that students observe, internalise, and associate with concrete elements influence the development of accurate perceptions of scientists. In addition, textbooks used as instructional materials feature various scientists and describe their characteristics. Therefore, we may conclude that school-based educational materials play a significant role in shaping students' mental representations of scientists. In conclusion, while students appear to

hold a generally accurate understanding of the characteristic attributes of scientists, they also demonstrate persistent gender and physical stereotypes that have endured over time. Gender- and age-based differences in students' mental representations suggest that these variations stem not from biological factors, but rather from pedagogical development and lived experiences. Within the context of the Social Studies Course, students' perceptions of scientists develop not only in terms of cognitive understanding but also through the axes of values education, personal development, and creative thinking. Curriculum and instructional activities should be structured to foster both intellectual creativity – often observed in female students – and practical creativity – more commonly expressed by male students – in a more balanced and inclusive manner.

A scientist does not solely work within the confines of a laboratory but also conducts research in natural and social environments, addressing issues related to human beings and society. When necessary, scientists engage in field-based practices across diverse settings to develop effective solutions to real-world problems. In this regard, the implementation of science workshops can enhance students' perceptions of scientists and foster greater interest in scientific activities. By increasing the number of experimental and practice-based activities, students can be introduced to scientists actively working in the field. Prominent scientists – particularly from universities – may be invited to schools to arrange school-based science events. To break the prevailing stereotypes about female scientists, concrete examples and engaging scientific activities can be developed through textbooks and Web 2.0 tools, fostering an inclusive and enjoyable learning environment.

Data Availability

The datasets presented in this study are not publicly available for privacy reasons. This data are available from the corresponding author on reasonable request.

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Authors' Contributions

Both authors contributed equally to the publication. Both authors drafted and reviewed the final manuscript.

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