Medeniyet Kültürel Araştırmalar Belleteni, İMÜ Edebiyat Fakültesi Dergisi, Sayı: 8, Cilt: 5, 2025, s. 01-15, ISSN:2792-0348, doi: 10.60051/medbel.1698216

More Than "A Light": A Linguistic Analysis on the Analogy-Based Conceptualisation of *Science* and *Scientist*

Bir Işıktan Fazlası: *Bilim* ve *Bilim İnsanının* Benzetme Temelli Kavramsallaştırılması Üzerine Dilbilimsel Bir İnceleme

Nurbanu KORKMAZ*

ÖZ

Bu çalışma, üniversite öğrencilerinin "bilim" ve "bilim insanı" kavramlarını nasıl kavramsallaştırdıklarını incelemeyi amaçlamaktadır. Bu amaçla, Hacettepe Üniversitesi'nde Felsefe, Biyoloji ve Dilbilim bölümlerinden toplam 90 öğrenciye açık uçlu sorular içeren betimleyici bir anket uygulanmıştır. Katılımcılardan, "Bilim … gibidir çünkü … " ve "Bilim insanı … gibidir çünkü …" ifadelerini tamamlamaları ve bu benzetmelerini gerekçelendirmeleri istenmiştir. Yapı Eşleme Kuramı (Structure Mapping Theory, Gentner, 1983) çerçevesinde gerçekleştirilen veri çözümlemesinde, katılımcıların bilim kavramını genellikle *ışık, doğa, nehir, uzay* ve *yaşam* gibi benzetmelerle tanımladığı belirlenmiştir. Bu benzetmeler, bilimin dinamik, sistematik ve yönlendirici yapısına işaret etmektedir. Öte yandan, bilim insanı kavramı *çocuk, astronot, madenci, sanatçı* ve *meşale/ışık taşıyıcısı* gibi benzetmelerle ifade edilmiştir. Bu benzetmeler, bilim insanının keşfetme, yaratıcı düşünme, sabır ve merak unsurlarını vurgulamaktadır. Çalışmanın sınırlılıkları arasında örneklem büyüklüğünün sınırlı olması, kullanılan anket sorularının kapsamının dar olması ve nicel analiz yöntemlerinin kullanılmaması yer almaktadır. Bu bağlamda, gelecekteki çalışmalarda daha geniş örneklemlerle ve nicel analizlerle daha kapsamlı değerlendirmeler yapılması önerilmektedir.

Anahtar Kelimeler: Bilim, Bilim İnsanı, Kavramsallaştırma, Yapı Eşleme Kuramı, Benzetme

ABSTRACT

This study aims to explore how university students conceptualise the notions of "science" and "scientist." To accomplish this, a descriptive questionnaire including open-ended prompts was administered to 90 undergraduate students from the Philosophy, Biology, and Linguistics departments at Hacettepe University. The participants were asked to fill in the statements such as "Science is like… because …" and "A scientist is like … because …" and to provide reasonable arguments for their analogies. The data analysis was conducted within the framework of Structure Mapping Theory (Gentner, 1983), focusing on identifying relational structures underlying the participants' analogical expressions. The results of the present study showed that the concept of science was primarily associated

* Dr. Öğr. Üyesi, Ağrı İbrahim Çeçen Üniversitesi, İngiliz Dili ve Edebiyatı Bölümü, *nkorkmaz.ling@gmail.com* (https://orcid.org/0000-0002-7254-781X).

Gönderim Tarihi: 13 Mayıs 2025 – Kabul Tarihi: 30 Haziran 2025

with analogies such as *light*, *nature*, *river*, *space* and *life*, emphasising its dynamic, systematic and guiding nature. In contrast, the concept of the scientist was conveyed through analogies including *child*, *astronaut*, *miner*, *artist*, and *torchbearer*, emphasising qualities such as exploration, creativity, perseverance, and curiosity. The study has three main limitations: a relatively small sample size, the limited scope of the questionnaire, and the lack of quantitative analysis. Future research is recommended to include larger sample sizes and quantitative approaches to validate the findings more robustly.

Keywords*: *Science, Scientist, Conceptualisation, Structure Mapping Theory, Analogy

Extended Summary

The current study examines how university students studying in a variety of fields conceptualise 'science' and 'scientist', with a focus on the analogies. The study was conducted using Structure Mapping Theory (SMT), proposed by Gentner (1983), which provides a cognitive framework for understanding how people create meaning through analogy. Through analogical concepts, the study sought to investigate how students at Hacettepe University, studying in different subjects, namely philosophy, biology and linguistics, conceptualise science and scientists.

A total of 90 undergraduate university students participated in the study. The data were collected using a descriptive questionnaire that with open-ended questions such as "Science is like ...... " and "A scientist is like ...... ". After answering these questions, the participants were asked to provide their own reasonable arguments. This qualitative approach facilitated the identification of the underlying analogical mappings that underpinned participants' conceptualisations.

The analysis of the data revealed that the participants conceptualised science and scientists through a variety of analogies. As evidenced by analogies such as *light, nature, river, cosmos, space* and *life*, science was primarily associated with assertive, organised and guiding aspects. For example, the *river* analogy, for example, underlines the pervasive flow and transformative potential of science, while the *light* analogy emphasises science's role in illuminating knowledge and dispelling ignorance.

The scientists' conceptualisations, on the other hand, were structured by analogies that emphasised inquiry, perseverance and discovery. The most common analogies included *torchbearer*, *miner, artist, astronaut* and *child*. For example, the natural curiosity and adventurous spirit of the scientist were highlighted by the *child* analogy, which likened them to a child's sense of wonder and constant questioning. The *astronaut* analogy portrayed the scientist as a fearless adventurer exploring unexplored intellectual frontiers.

The results suggest that although the participants used various analogies, there was significant thematic overlap. Both *science* and *scientists* were portrayed as dynamic, evolving and influential forces steering intellectual and societal progress. These analogies are consistent with previous literature, which has often portrayed science as a transformative and boundary-pushing construct (Gonsoulin, 2001; Knudsen, 2003).

There are several limitations to the study, one of which is that the sample size is relatively small, which may impact on the extent to which the findings can be generalised. In addition, the reliance on open-ended prompts rather than structured quantitative analysis limits the depth of analysis. Future studies could use larger samples and quantitative methods, such as Likert-scale surveys, to confirm the observed analogous patterns and identify statistically significant differences between disciplines.

In conclusion, the research provides important insights into how university students conceptualise science and scientists through analogical mappings. The study advances understanding of the perception and articulation of scientific concepts in different academic contexts by identifying common analogies and exploring their underlying relational structures. The implications of these findings extend to science education, where the strategic use of analogy may enhance conceptual clarity, promote interdisciplinary understanding, and foster sophisticated science literacies.

Introduction

Mustafa Kemal Atatürk's famous statement, “Hayatta en hakiki mürşid ilimdir” (The truest guide in life is science), encloses a profound legacy that should transcend time, from historical narratives to contemporary discourse and on to future generations. This message is prominently inscribed on the outer wall of the Faculty of Language and History-Geography at Ankara University, serving as a symbolic affirmation of the enduring importance of science as a guiding principle for humanity. The term "murshid" (guide) used in this context underscores the fundamental role of science as a compass that guides intellectual and social progress.

A closer look reveals the potential for further comparisons, although this one suggests that science is a significant cultural influence. It is undeniable that science has been a driving force throughout history, constantly evolving and serving human interests (Kuhn, 1962; Merton, 1973). Similarly, because of their innate interest and dedication to solve urgent problems, scientists are essential in forming society (Jensen et al., 2008; Polanyi, 1962). This dynamic relationship demonstrates how public perceptions of science and scientists, as well as the direction of scientific study, are influenced by cultural norms, societal needs, and technical environments (Latour & Woolgar, 1979). Understanding this mutual interaction is crucial to comprehending both the creation of scientific knowledge and the function of scientists in society as intermediaries between innovation and the general welfare (Jasanoff, 2004). This study explores how analogies are used to understand *science* and *scientists*. This pursuit is explained through the use of Structure-Mapping Theory (SMT).

SMT, a cognitive theory that explains how people learn and make sense of things through analogy, was proposed by Dedre Gentner in 1983. According to the theory, when people seek to understand a new situation or concept, they compare it to something that they already know. However, these analogies are not solely based on superficial similarities. Instead, they map the underlying relationship structures between the two situations. This process is called 'structure mapping'.

Through this process of structure mapping, individuals can identify essential similarities that transcend superficial ones, thereby fostering deeper conceptual understanding. Instead of only matching objects or characteristics, this entails aligning relationship structures across two domains, according to Gentner (1983). Surface-level characteristics like form, color, or discrete characteristics that don't represent the underlying structure of relationships are referred to as superficial similarities. Structure mapping, on the other hand, places more emphasis on deeper, systematic correspondences that underpin analogical thinking, such as causal, functional, or hierarchical linkages. This kind of mapping facilitates conceptual transfer and encourages abstract thought by enabling students to make deductions from one domain and apply them meaningfully to another.

The present study focuses primarily on the source-target dichotomy, one of the three fundamental aspects of Gentner's (1983) theory: structural alignment, systematicity, and the source-target dichotomy. In this context, the analogy "A T is (like) a B" establishes a conceptual mapping in which T represents the target domain to be explained and B serves as the source domain that provides the basic structure for the analogy.

According to Gentner (1983), there are four distinct types of relational comparisons in SMT: literal similarity, analogy, abstraction, and anomaly.

1. *Literal Similarity* involves mapping a significant proportion of predicates from the base to the target, with minimal non-mapped predicates. This type of comparison highlights direct, observable resemblances between the two domains (Tversky, 1977).
2. *Analogy* refers to the transfer of relational predicates from the base to the target, with fewer or no object properties being mapped. This type emphasises structural alignment without preserving specific object attributes.
3. *Abstraction* is characterised by a comparison where all predicates from an abstract base domain are mapped onto the target domain, resulting in a highly generalised relational structure.
4. An *anomaly* involves comparisons in which both the base and target share minimal common predicates, leading to incongruent or illogical mappings.

Table 1, adapted from Gentner (1983, p. 161), illustrates these distinctions using the Rutherford analogy:

Table 1. Types of analogical comparisons in structure mapping theory and their relational mappings (adapted from Gentner, 1983)

Comparison Type	Object Mappings	Relational Mappings	Example
Literal Similarity	Many	Many	"The K15 solar system is like our solar system."
Analogy	Few	Many	"The atom is like our solar system."
Abstraction	Few	Many	"The atom is a central force system."
Anomaly	Few	Few	"Coffee is like the solar system."

Object mappings concentrate on surface-level commonalities, such matching items or components, and provide direct correspondences between particular pieces or things in two domains. For instance, in the above Table 1 , both systems have stars, planets, orbits, and similar components. The elements correspond one-to-one in both identity and structure. Relational mappings, on the other hand, emphasize deeper structural or functional similarities by concentrating on how these parts match in terms of relationships and interactions. For instance, because the objects being compared share many components and their relationships, there are many object and relational mappings in real similarity comparisons like electrons orbit nucleus. The significance of relational mapping in comprehending deeper connections beyond surface attributes is shown by the fact that, in analogies, few things exactly match, but numerous relationships between these objects are aligned.

The present study seeks to expound how university students conceptualise the notions of "scientist" and "science" and whether these conceptualisations exhibit analogous patterns across different fields. Specifically, the study addresses two primary research questions: (1) How do university students conceptualise the terms "scientist" and "science"? and (2) Is the perception of the concepts of "science" and "scientist" similar among university students, and if so, what are the analogies proposed by the participants?

1. Literature Review

Extensive research has been conducted to explore the conceptualisations of science and scientists across diverse populations. Given the abundance of studies within the Turkish literature, the literature review section of this study primarily focused on research conducted in Turkey to distinguish it from prior investigations. The selected articles from the literature exemplify the conceptualisation of science from various perspectives. These studies can be categorised based on the participant categorisations, methodological approaches, and conceptual focus.

Firstly, participant-based categorisations include research examining young children's understanding of science and scientists (Newton & Newton, 1992; Ayvacı et al., 2006; Güler & Akman, 2006; Kılıç, 2010; Korkmaz and Kavak, 2010), metaphorical perceptions of science among students (Doğan Bora et al., 2006; Muşlu and Akgül, 2006; Türkmen, 2008; Bıyıklı et al., 2014; Özgün et al., 2018; Bartan, 2019), and pre-service science teachers' conceptualizations of these terms (Yenice & Ceren-Atmaca, 2017; Bartan, 2019). Additionally, the literature includes studies focusing on teacher candidates, such as those conducted by Çermik (2013), Derman and Derman (2015), and Özgün et al. (2018), and along with studies that include participants beyond the preschool age group, such as Balkı et al. (2003), Doğan Bora et al. (2006), Kaya et al. (2008), Kılıç (2010), Uçar (2012), Keser (2012), Camcı Erdoğan (2013), Kara & Akarsu (2013), Bıyıklı et al. (2014), Özsoy and Ahi (2014), Doğan (2015), Aktamış & Dönmez (2016), and Turgut et al. (2017).

Secondly, regarding methodological approach, the Draw-A-Scientist Test (DAST) developed by Chambers (1983) has emerged as a significant tool to conceptualise the characteristics of a scientist through visuals (Yontar-Toğrol, 2000; Gonsoulin, 2001; Finson, 2002; Karaçam, 2015). This test enables us to understand how children envision the concept of science and what the indicators of science look like.

Thirdly, the methodological focus is on studies that have investigated how science and scientists are represented metaphorically (Knudsen, 2003; Dikmenli, Çardak & Yener, 2012; Bıyıklı et al., 2014; Şenel & Arslan, 2014) to reveal the underlying conceptual frameworks.

The present study aims to build on the existing body of literature by focusing on the structure mapping domains of "science" and "scientist," employing analogical reasoning to identify commonalities in how these concepts are perceived by the undergraduate students.

2. Methodology

The methodological framework of this study was designed to comprehensively examine undergraduate students' conceptualizations of "science" and "scientist". The participant group comprised 90 undergraduate students enrolled at Hacettepe University in Ankara, with an equal distribution of 30 students selected from the following departments: Philosophy, Biology, and Linguistics. This stratified sampling strategy was employed to encompass the two principal branches of science and a branch of humanities-—as represented by Biology, Linguistics, and Philosophy, respectively (Pitt, 2018). Within each disciplinary group, the gender distribution was balanced, with 15 female and 15 male students, ensuring diversity in participant demographics and reducing potential biases in the data collection process.

A two-part questionnaire was used to collect data. To provide a comprehensive profile of the participants, the first part included demographic data such as academic department, gender and age. These data were collected to support participant diversity and contribute to the overall design of the study, although age and gender were not the primary variables of interest. The second section of the questionnaire contained open-ended prompts designed to elicit analogical relationships. Participants were encouraged to provide a plausible explanation for the analogy by completing the statements 'Science is like ....because' and 'A scientist is like .... because'. This open-ended format facilitated the identification of conceptual framing and analogies, and enabling a more refined analysis of how students from different disciplines understand and conceptualise the concepts of science and scientists.

3. Data Analysis

The process of data analysis was meticulously designed to address the two primary research questions methodically. The analysis began with the first question and was followed by the second. This section thoroughly examines the participants' conceptualisations of the terms "science" and "scientist." The primary aim of the study was to develop a meta schema effectively reflects the insights derived from analogical reasoning.

3.1. Conceptualisation of science

The analysis of participants' responses regarding the concept of "science" revealed four distinct conceptual schemas, each highlighting different dimensions of scientific understanding. The conceptual schemas are delineated as follows:

3.1.1. *Conceptual schemas*

Science has a dynamic structure in itself

In this particular context, the term 'dynamic' is employed to denote a structural entity that is characterised by perpetual transformation and adaptability, exhibiting a propensity for self-renewal. It is precisely this process that distinguishes science as a discipline. For instance, science is open to modification and evolution due to new tests, data and observations. Over time, scientific theories may be modified or even abandoned if they are found to be false. The path of science varies according to societal demands and technological advancements.

Science is directive

By influencing the technical, economic, and cultural paths of civilizations, science serves as a guiding force. Its effect goes beyond technological developments to change mental models, which in turn affects the types of questions people ask and the choices they make in their day-to-day lives. Through its dual function, science shapes both social structures and personal worldviews by transforming internal thought patterns in addition to propelling exterior advancement.

Science is unhindered

Science is unrestricted by its never-ending quest for knowledge. Humans have always tried to understand the cosmos, nature, their environment and themselves, and they always will. Therefore, regardless of any external obstacles such as economic impact or social pressure, scientific research will continue to progress. These days, globalisation makes it almost impossible to stop or limit science completely.

Science is systematic

In order to use a scientific approach, people must create questions, plan and carry out experiments to answer these questions, assess the results critically, and make inferences using a methodical procedure. This method guarantees the creation of information that is impartial, trustworthy, and repeatable, serving as the cornerstone of scientific investigation and confirming its conclusions in many settings (Kerlinger & Lee, 2000).

3.1.2. *Analogies of the conceptualisation of science*

The following are the total realisations drawn from the answers provided to the second research question, taking into account the explanations offered by the participants. Since the primary focus of our study is merely on similarities, we would want to welcome all three of the different fields that share the exact similarity. A thorough explanation for each of the six analogies of science is as follows:

Light/sun/torch

There are three reasons why science is compared to light or the sun. Firstly, light illuminates one's surroundings as well as one's position. In this sense, scientists make discoveries for the benefit of everyone, not just themselves. Secondly, the idea that humans are in charge is highlighted, since they can hold the torch in their hands and light it themselves. Thirdly, by illuminating the surrounding area, the torch demonstrates its ability to keep burning over time. Similarly, science is compared to a torch because it evolves and changes over time.

The following Extract 1 illustrates how science is perceived as a sun:

(1) *Science is like the sun, because if the sun doesn't rise, the world remains in darkness, and when it does, we get a little closer to the reality of everything.* (PHI_26)

The ability of science to shed light on the entire planet at once is comparable to that of the sun. This analogy is fitting for the universal creation of knowledge and scientific facts applicable to everyone. Science generates light independently. In other words, science's internal sources of technique, observation and reasoning are more important than external ones.

Nature

As science constantly changes and evolves, nature changes with the seasons and evolves. Some new information is confirmed and developed, while some is refuted. There is a logical sequence to all these advances and modifications. Science recognizes that its systems are interconnected. For example, ecosystems, air, water and living creatures are interconnected.

In the following Extract 2, the participants emphasize that science has a variable structure just like nature:

(2) *Science is like nature because science, like nature, is studied in a very broad framework. In nature, the seasons change over time and we can liken this to the way scientific knowledge changes.* (LING_16)

A similar systemic relationship exists in science, where hypotheses, facts and procedures are all interconnected. A single observation can impact the entire system. Despite the initial illusion of complexity or unpredictability, this systematicity is guided by predictable laws.

Science is perceived as constantly evolving, much like natural processes that undergo cycles and transformations. As nature renews itself, science progresses through continuous inquiry, integration of new data, and adaptation to changing contexts.

Universe

Although science is not the universe, its structure and operation are incredibly similar to those of the universe. Both appear to lack in meaning, have ambiguous borders and are enigmatic, multi-layered, open-ended systems. The boundaries of the cosmos are unknown to us. Furthermore, science never asserts that it is 'complete' because every response generates new questions and advances the field. Science has multiplicities, subsystems, and systems. Black holes, stars and galaxies make up the cosmos.

In the Extract 3 given below, science is compared to the universe and its vastness is emphasized.

(3) *Science is like the universe because it is a phenomenon that has no end, that expands as we learn, and that brings happiness. Just like the universe, there are a number of interconnected phenomena that provide order, that have consequences for each other.* (BIO_5)

Science encompasses numerous systematic knowledge domains, including physics, chemistry, psychology, and sociology. Science provides an objective perspective that 'does not put human beings at the centre', just as we cannot place the Earth at the centre of the cosmos.

Space

Space seems to have no limits, as it is very vast and eternal. Just as humans do not know their limits, every scientific discovery reveals new unknowns. The boundaries of science are blurry and constantly expanding, much like space itself. For instance, humans have not yet visited every planet, star and galaxy.

In the Extract 4, the participant likens science to space and emphasizes that it has no limits.

(4) *Science is like outer space because science is a field with unlimited data sources.* (LING_18)

There are still unsolved problems, unanswered questions and unexplored areas in sicence. While navigating both science and space can be challenging, there are tools to assist. For instance, the maps of difficult-to-navigate stars in space, for instance, were computed using telescopes and compasses. Similarly, in science, there are rules pertaining to method, logic, experimentation and observation.

Life

Science is a human endeavour that seeks to understand life. However, life itself is a process that includes our emotions, bodies and relationships. Science is an instrument and a viewpoint that observes, clarifies and sometimes modifies this process. There are many parallels between life and science because both are dynamic and ever-changing processes. Life is a process of change from conception to death.

In the Extract 5, the participant likens science to life, pointing out that both are developing and in a state of dynamism.

(5) *Science is like life because both our life and science develop over time. This development happens through our thoughts and actions. Our thoughts feed science so that it is easy to live life with people.* (LING_22)

Similarly, science is an ever-evolving, dynamic process that adapts to new knowledge. Change in both life and science occurs due to learning, experience, error, observation and reflection. Both include possibilities and probabilities, but not certainties.

River

Although it is not a river, science is quite similar to one in that it is an unhindered, life-giving, ever-changing process with many river mouths. Just as a river never stops flowing, research is an ongoing activity. Over time, the body of knowledge expands, changes and adopts new paths. While the source of a river is known — a mountain or snow, for example — it takes time to figure out how far it will run and which tributaries it will divide into. Like other disciplines, science begins with specific questions and is grounded in certain sources before expanding into various fields.

In the Extract 6, the participant resembles science to a river. S/he emphasizes that science, like a river, has essential components.

(6) *Science is like a river because, just like a river, there are factors that create the character of the water such as temperature, flow rate, length, etc.* (BIO_9)

Like a river, science can be both clear and muddy. Muddy water is an example of a complex subject incorporating several factors, whereas clear water is an example of a simple scientific topic with a straightforward answer. Nevertheless, both are part of the same river.

3.2. Conceptualisation of scientist

The analysis also identified key conceptualisations of the "scientist" as reflected in participants' analogies:

3.2.1. *Conceptual Schemas*

The scientist is a discoverer/producer

One of the most important characteristics of a scientist is their ability to produce and discover more than others. Scientists promote research by revealing new knowledge through their observations and enquiries into the environment around them. At the same time, we could argue that a scientist's ability to explain existing ideas and develop new ones indicates of their constructive nature. By adding new knowledge and improving upon existing knowledge, scientists advance the field of science.

The scientist is the one who perceives the invisible

The phrase 'seeing the invisible' refers to a scientist's ability to identify hidden connections, occurrences or phenomena. This skill involves careful observation and in-depth analysis of outcomes. Scientists can accurately determine the causes of events, identify connections or systems based on reality, and use their expertise and experience to discover details that others overlook. By doing so, they push the boundaries of science and uncover previously unknown knowledge.

The scientist is curious

Curiosity is the desire to learn more about a particular topic, regardless of how familiar one is with it. Curiosity is one of the most important traits of a scientist because it's a component of the scientific process. In this regard, it is possible to argue that the initial stimulus is the interest that emerges before a scientific inquiry is formulated. It is often known that the main driving force behind scientists' efforts to comprehend and explain the world around them is curiosity.

The scientist has a never-ending endeavour

The "never-ending endeavour" is a characteristic of the scientific mind that reflects persistence and determination in the face of long-term goals, obstacles, and uncertainties that are part of scientific research. Despite obstacles, scientists may conduct more research and increase scientific understanding by remaining interested in their field despite obstacles.

3.2.1. ***Analogies of the conceptualisation of scientists***

The following are the total analogical relations drawn from the answers to the second research question, taking into account the explanations offered by the participants. Since the primary focus of our study is merely on similarities, we would want to welcome all three of the different fields that share the exact similarity. A thorough explanation of each of the eight analogies of a scientist is given in this section.

Child

Like scientists, children frequently ask questions such as 'Why?' and 'How?' In fact, curiosity and diversity are the primary motivations for learning in children and for research in scientists is a sense of curiosity and discovery. Children learn about the world through play. Similarly, scientists conduct experiments, make observations and learn from their mistakes to discover the truth. The methods scientists use in their experiments are similar to those used by children in their learning process.

In the following Extract 7, a scientist is likened to a curious child who constantly asks questions. Science, in its own unique way, consists of questions and answers to questions.

(7) *A scientist is like a curious child because he or she is constantly asking questions, trying to understand the situation and developing ideas.* (LING_9)

Children can also create made-up scenarios. Scientists build models and formulate theories. Innovation is the driving force behind scientific progress. Children have perspectives that adults do not. Additionally, scientists can often think outside of the box.

Astronaut

Just as scientists search for unanswered questions in the world of knowledge, astronauts explore the unknown of space since both of them exceed established boundaries. Astronauts act with great care, expertise, and training, much like scientists. Both use sophisticated instruments and techniques in this process. They also both dare to explore. Despite being alone in space, astronauts impact the Earth through their work.

In the Extract 8 given, both the scientist and the astronaut are likened to each other in terms of discovering the unknown.

(8) *A scientist is like an astronaut because he is constantly seeking to make new discoveries in space, which is his field of research* (BIO_14)

Similarly, even though scientists may work alone in a laboratory or surrounded by books, humanity can benefit from their expertise. While the astronaut physically explores the cosmos, the scientist embarks on an intellectual quest to understand how it functions.

Miner

In order to locate a mineral from the underground, a miner must dig a well below the surface. Meanwhile, the scientist seeks to understand the structures, principles and reasons behind what is visible on the surface. The miner removes the ore, which is undetectable to the naked eye. Similarly, the scientist uncovers unseen rules, structures and correlations. In both situations, knowledge or metallic value is concealed.

In the Extract 9 given, the participant likened the scientist and the miner to each other in terms of uncovering what is valuable.

(9) *A scientist is like a miner because light is his science and he uses it to find valuable ores after much research and effort. He shares these gems with people and these gems spread all over the world.* (PHI_27)

Both mining and scientific research require perseverance and patience. Finding and making sense of data takes time: searching, sorting and trying again. Additionally, a scientist uses instruments such as microscopes, test tubes and statistical software, whereas a miner uses picks, shovels and torches.

Captain

While a captain uses maps, stars and a compass to navigate a ship, a scientist uses facts, hypotheses and techniques to navigate the unknown. As with the study process, this journey may be turbulent at times.

In the following Extract 10, the leader aspect of a scientist and a captain is emphasized and their role as a guide is underlined.

(10) *A scientist is like a captain because he is the one who steers the ship through the ocean and makes sure that it gets safely to the harbor. In any storm, he or she can make quick decisions and overcome difficulties.* (PHI_18)

A scientist is constantly making choices, managing risks and exploring new avenues, much like a captain. A scientist works hierarchically and collaboratively with research assistants, colleagues and students, much like a captain works with the crew. The captain knows the destination, but not the obstacles he will face along the way. Similarly, the scientist seeks answers to unsolved issues, with knowledge being the ultimate goal, although the journey is unpredictable and full of surprising discoveries.

Artist

Just as an artist does, a scientist shares new findings during the process of discovery. While the artist uses creative expression to offer unique perspective to the audience, the scientist relies on observation and hypothesis-building to generate scientific knowledge. In both fields, creative thinking serves the goal of exploring and interpreting the unknown. However, scientists use critical thinking and observation to uncover new information.

In the Extract 11 given, the participant emphasized the role of being creative in the production of scientific knowledge by making an analogy between a scientist and an artist.

(11) *A scientist is like an artist because both art and science require creativity, open- mindedness and the ability to innovate.* (LING_20)

Conversely, artists create new works using their artistic intuition and creativity. Thus, scientists employ their artistic abilities to explore unexplored areas of nature or the universe, much like artists.

Torchbearer- A person carrying light/torch

Just as a light in one's hand enlightens the dark, a scientist investigates the unknown and discovers crucial information. Thanks to scientific illumination, we start to see facts that were previously invisible to us. When someone carries a light, they enlighten themselves and those who follow them. Scientists also create new technologies, cures and ways of thinking, opening doors for humanity and themselves.

In the following Extract 12, the participant likens the scientist to a person who holds a light in his hand and illuminates the darkness. The scientist also sheds light on human life with his studies.

(12) *A scientist is like someone holding a light in his hand because he shines it into the invisible and reveals the why and how of something.* (PHI_1)

Not everything can be illuminated; scientists cannot see everything at once, but their information helps them to delve further into some areas. This fits well with the methodical advancement that characterises scientific enquiry. Presuming in the dark with light requires bravery. Similarly, scientists adventure into the unknown, taking chances, asking questions and conducting research.

Ant

Ants work vigorously and continuously, moving tiny components. Similarly, scientists conduct extensive research, accurately collect data and perform detailed analyses. Both ants and scientists use small steps to build large structures, just as ants do in a colony.

The following Extract 13 highlights the similarities between the scientist and an ant. It is highlighted that scientists, like ants, are always working, producing, and adding value to life.

(13) *A scientist is like an ant because he or she never stops working. Just as the ant runs after food, the scientist runs after knowledge guided by his/her intellect.* (BIO_30)

Scientists usually collaborate as part of a research group or laboratory team rather than working alone. Despite their silent and sometimes undetectable labour, ants have a significant impact on their surroundings. Through years of research, scientists also contribute to society, often working behind the scenes.

Chef

A chef is like a scientist, using their culinary expertise to create new recipes. Using the ingredients available, a chef can create an entirely different dish.

The following Extract 14 here compares a scientist to a chef and draws attention to the fact that the chef cooks a good meal using different ingredients, just as a scientist creates a scientific work by combining different parts.

(14) *A scientist is like a cook because he has ingredients and with them. He creates something new. Sometimes he tries but fails. Then he tries again and again. He comes up with a good flavour and he tests it on all the people.* (LING_4)

Failures are possible, but the chef never gives up and continues to try. Eventually, he may achieve success and share his discoveries with everyone.

This can have an impact on people's lives and can be enjoyed by everyone.

Conclusion

The present study sought to explore how university students conceptualise the notions of "science" and "scientist" through analogical relations. By employing structure mapping theory as a theoretical framework, the study aimed to enlighten the underlying relational structures that inform these conceptualisations and to identify the prevalent analogies students employ in articulating their perceptions of these constructions.

The findings indicate that participants employed a diverse array of analogies to represent both "science" and "scientist," reflecting distinct yet overlapping conceptual frameworks. Specifically, the conceptualisation of science was predominantly facilitated through the utilisation of analogies, with prominent examples including *light, nature, rivers*, *the universe, space*, and *life*. These analogies highlight the persistent, dynamic, and systematic nature of science. The use of analogies, such as those drawn between *light*, *a torch*, and the *sun*, collectively serves to emphasise the role of science as a guiding and enlightening force that eradicates ignorance and illuminates the path towards knowledge. Similarly, the nature and river analogies emphasised science's inherent movement and capacity for perpetual renewal, while the universe and space analogies highlighted its boundlessness and limitless potential for exploration. These conceptualisations align with the previous literature on science metaphors, which often depict science as a dynamic, evolving, and expansive construct (Gonsoulin, 2001; Knudsen, 2003).

Conversely, the conceptualisations of "scientist" were framed through analogies such as *child, astronaut, miner, captain, artist, torchbearer*, and *ant*. These analogies highlighted the scientist's role as a continuous explorer of truth, an investigator into uncharted territories, and a generator of new knowledge. For example, the *child* and *ant* analogies emphasised the scientist's insatiable curiosity and meticulous work ethic. In contrast, the *astronaut* and *miner* analogies highlighted their readiness to explore the unknown and uncover latent insights. The *artist* analogy, in particular, emphasised the creative and imaginary nature of scientific inquiry, a perspective that aligns with prior studies emphasising the imaginative dimensions of scientific exploration (Newton & Newton, 1992; Darian, 2000).

From a structural mapping perspective, the identified analogies revealed a consistent pattern in which students leveraged familiar concepts to construct more abstract representations of science and the scientist. Aligning the base (familiar domain) with the target (scientific concepts) enabled participants to articulate complex ideas through accessible and relatable frameworks. Such analogical reasoning facilitated deeper conceptual understanding and underscored the relational nature of scientific thinking, as posited by Gentner (1983).

Limitations and Future Directions

Despite its contributions, the current study has limitations. First, the relatively small sample size may limit the generalizability of the findings. Expanding the participant pool to include a broader and more diverse range of academic disciplines could yield more comprehensive insights into the analogical conceptualisations of science and the scientist.

Secondly, the study utilised open-ended survey prompts to elicit analogies. While these effectively captured diverse perspectives, they may have constrained the depth of participant responses. It is recommended that future studies incorporate more structured questionnaires, including specific analogies or predefined categories, to refine further and validate the identified conceptual frameworks.

Thirdly, the study employed a qualitative approach, utilizing thematic analysis to identify commonalities and conceptual patterns. A more comprehensive quantitative analysis could validate the observed patterns statistically, thereby enhancing the reliability and generalizability of the findings. Incorporating quantitative measures, such as Likert-scale items or semantic differential scales, can facilitate cross-sectional comparisons and the identification of significant differences across academic disciplines.

Finally, the present study constitutes an expanded and revised version of a research assignment conducted during the doctoral process. The findings of this study provide a foundation for the exploring the diachronic evolution of conceptualisations in science. Such an evolution may be examined through the lens of analogies, investigating how they may shift over time or in response to educational interventions.

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