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Science student teachers' metaphors for scientists

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Abstract

The purpose of this study is to investigate science student teachers' perceptions of the concept of 'scientists' by means of metaphor analysis. This study focuses on the following questions: (1) what are the metaphors produced by science student teachers to describe 'scientists'? (2) what categories of common features can be derived from these metaphors? The study was carried out among the 1st, 2nd, 3rd and 4th grade students studying in the Programme of Primary Science Education at Selcuk University in November 2010. Data were collected from 374 participating students using an open-ended questionnaire and analysed using content analysis techniques. As a result of the data analysis, it was found that 85 valid metaphors were developed by the participating students. These metaphors were classified using nine conceptual categories: (1) the scientist as a hardworking and productive figure; (2) the scientist as a wise figure; (3) the scientist as a figure devoting himself/herself to humanity; (4) the scientist as a figure steering the society; (5) the scientist as a curious figure; (6) the scientist as an antisocial figure; (7) the scientist as a questioning-researching figure; (8) the scientist as an objective figure, and (9) the scientist as a mad figure. The results of this study have shown that, as well as having primarily positive perceptions of the concept of a 'scientist', science student teachers also have some negative perceptions and utilise stereotypical images, such as in the categories of the scientist as an asocial figure and the scientist as a mad figure. These results are compared with the relevant literature and recommendations are provided.

Keywords: Images of the scientist; metaphor analysis; science student teachers

1. Introduction

The word 'metaphor' is derived from the Greek root words 'meta' (meaning 'to transfer') and 'pherein' (meaning 'to bear') [1]. Traditionally, a metaphor is defined as a poetical image and a

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rhetorical tool which is limited to use in literature. Metaphor is typically seen as a characteristic of language. Metaphor, which was defined as an embellishment or a style of speaking in the past, is today considered as the primary mechanism of thinking and reasoning. Metaphors are very popular in people's daily lives. People largely use metaphors in order to conceptualise, represent or share their thoughts and actions [2]. To Lakoff and Johnson [2], a metaphor is a mental structure that helps us to structure our experiences and develop our powers of reason and imagination. This aspect of metaphors arose from a perspective called 'cognitive metaphor theory' which was put forward by Lacoff and Johnson [2]. This theory of metaphor shows that a metaphor is not only a figure of speech, but also one of the basic aspects of how language and the human mind works. Metaphors are usually used for the purpose of correlating something unknown or barely known with something better known. A typical use of metaphor involves using a source domain to facilitate reflection on and understanding of a target domain [3]. Metaphors make us think about something as another thing. A metaphor is actually a way of understanding one reality by means of another reality [4]. Lakoff and Johnson [2] asserted that metaphors are important for all kinds of comprehension and reasoning. To Lakoff and Johnson, the use of metaphor is significant when learning about abstract concepts which are being indirectly taught.

Through an examination of the metaphors used by people in defining their experiences, beliefs and opinions, researchers can find the meaning underlying the expressions that the writer or speaker has directly or unconsciously put forward [5]. A considerable number of studies in the field of education have employed metaphor analysis as a research tool. These studies usually focus on the evaluation of the beliefs and attitudes of pre-service and in-service teachers, teacher-student interaction and the opinions of teachers about instruction and education [6-12]. For example, Saban et al. [11] investigated the metaphors that prospective teachers in Turkey formulated to describe the concept of ''a teacher''. In this study, 64 valid metaphors were analysed and 10 main conceptual categories were identified. Mahlios and Maxson [8] categorised 253 pre-service teachers' metaphors for teaching and identified four themes: teaching as telling, teaching as nurturing, teaching as guiding and teaching as stimulating. Their study found that pre-service teachers' personal metaphorical beliefs held more importance for them than the concepts and theories commonly taught in their teacher training programmes.

The perceptions of a 'scientist' belonging to students from different age groups have been the subject of interest in educational research for a long time. Several methods have been used in studies of students in order to capture their images of a scientist. The draw-a-scientist test (DAST) [13], a free word association test [14, 15], Likert-scale items [16] and interviews [17] are some of these methods. In the DAST organised by Chambers [13], the students were asked to draw a picture of a scientist on white paper. These drawings were analysed using seven standard indicators [18]: (1) lab coat (2) eyeglasses, (3) facial hair, (4) symbols of research, (5) symbols of knowledge, (6) symbols of technology, (7) relevant captions.

Students' perceptions and images of scientists have been investigated using the DAST in many studies [19-27]. These studies have shown that there is a stereotypical image of scientists among students of all ages, and that this image is usually negative. As interpreted by Schibeci [28], it is quite discouraging that scientists usually have an unfavourable and a negative image among the students at any school level. Newton and Newton [29] found that the images held by the students had started to develop as early as elementary school, and that they remained the same for years even after changes to the syllabus. Furthermore, Chambers [13] found that not only

students but also adults including some scientists had stereotypical images of scientists. In addition, teachers also held these stereotypical images of a scientist, and these images had a tendency to affect their teaching in a negative manner [20]. The relation between the images of science and scientists in students' minds and their choice of career is fairly important. This is because students' attitudes towards science are largely influenced by their perceptions of science and scientists. The most important factors influencing students' choice of career includes advice from friends, family members, teachers and the media. All of these factors have an influence on the students' perceptions of what it means to be a scientist [26].

Although the perceptions and images held by students from different age groups about scientists have been researched using several methods, no research was found regarding the metaphors used by the students to describe scientists. The metaphors used in educational research allow the respondents to express their beliefs, feelings and opinions about the subject freely. On the other hand, metaphors help students to externalise their opinions about scientists and to make analysis easier. Carter [30] claims that metaphors present meaning which is difficult to obtain through literary language. For this reason, the metaphors used by science student teachers to describe scientists were researched in this study.

1.1. Purpose

The purpose of this research is to examine student teachers' perceptions of 'scientists using the metaphor analysis method. Within the frame of this general purpose, the following questions were asked: (1) what are the metaphors used by science student teachers to describe 'scientists'? and (2) what categories of common features can be derived from these metaphors?

2. Methodology

A qualitative research method with a phenomenological scientific design was used in this research. Phenomenological designs focus on phenomena that we are aware of, but do not quite understand the meaning of. A phenomenological design provides a suitable research platform for studies aiming to investigate phenomena that are not totally alien to us, but that we have difficulty understanding in full [31].

2.1. Participants

A total of 374 students who were studying to become science teachers at the Ahmet Kelesoglu Faculty of Education at Selcuk University in Turkey participated in this study. The average age of the students was 20.7 years old (range 18–25). The majority of the students were female (251 of 374). The study was conducted in October 2010.

2.2. Data collection

In order to determine the metaphoric depictions drawn by science student teachers regarding the concept of a 'scientist', the participants were asked to complete the following sentence: 'A scientist is like ... because ...' For this purpose, each participant was given a blank sheet of paper with this partial sentence written at the top, and they were asked to write down their thoughts using this statement and focusing on a single metaphor. At the start, the necessary explanations were made to the participants regarding metaphors. It was emphasised on several occasions that they had to liken the scientist to something, and give their reasons for doing so. According to

Saban [12, p. 428], the concept of 'like' is used to evoke an association between the subject of the metaphor and its source more clearly in studies using metaphors as a research tool. The concept of 'because' allows participants to provide a reason or a logical basis for their metaphors. Approximately 20 minutes were allowed for the participants to generate their metaphors. As the aim was to utilize the first metaphors that the students thought of, this length of time was considered to be sufficient. The metaphors gleaned from the 'A scientist is like ... because ...' sentences provided the main data source of this study. Metaphors have been used successfully as research tools in this manner in many studies [10-12].

2.3. Data analysis

The content analysis technique was used in this study in order to evaluate the data collected. The main purpose of content analysis is to access certain concepts and associations in the explanation of the data collected. The basic process of content analysis is to gather similar data within the framework of definite concepts and themes, and to organise and interpret them in a way that will be meaningful to the reader [31].

Written material that is obtained from open-ended questions or interview documents is usually used in metaphor analysis, and thus all of the metaphors which are determined can be examined several times. All of these metaphors are of great importance due to the need to provide reliable analysis results in this type of study. The written materials were examined carefully and repeatedly in order to guarantee that all of the metaphors were discovered. The first reading is an important phase in the quest to ensure that none of the metaphors are overlooked. In a nutshell, the first step of metaphor analysis is the determination of all of the metaphors in the written material. Schmitt [32, p. 371] stated that a word or an idiom can be seen as a metaphor first if it is understood to be above the literal meaning within a context, that is, if it has a figurative meaning. Second, the literal meaning has to be based on a source area, and third, the meaning is usually transferred to the target area, which is abstract.

The process of analysis and interpretation of the metaphors generated by the students was carried out as follows: first, the metaphors generated by the students were listed. Invalid metaphors were identified and excluded. In line with the purpose of this study, the students' responses were checked to see whether a metaphor had been clearly used. The metaphor on each student's paper was coded. The papers that contained no metaphors were marked. The metaphors written by the students were revised one by one and analysed in terms of: (1) the target of the metaphor; (2) the source of the metaphor; and (3) the relationship between the target and the source of the metaphor. During this process, it was found that three papers were blank, and eight papers contained no clearly stated metaphor. Furthermore, there was no parallel association between the target of the metaphor and the source of the metaphor on 11 papers. Thus, a total of 22 papers were eliminated, and 352 papers were included in the evaluation. Second, the metaphors generated by the students were categorised in terms of their similarities. Categories were developed for the metaphors according to their common features with regard to the term 'scientist'. A total of 352 metaphors generated by the students were categorised into nine categories. Third, the validity and reliability of the research were ensured. Validity and reliability are the two most important criteria in ensuring the plausibility of research results. In qualitative research, detailed reporting of the data and an explanation of how the researcher reached the given results are important criteria for validity [31]. In order to ensure the validity of this research, the process of gathering and analysing data has been explained in detail. Furthermore,

the findings gleaned from this research have been supported using the written statements of the students. The data collected for the purpose of guaranteeing the reliability of the research were primarily analysed by the researchers. Then, the researchers compared the results of the analysis and came to an agreement. After this, the metaphors within the categories developed in the study were analysed by a specialist. The metaphors developed by the students and the categories developed by the researchers were given to a specialist in a list. The researchers asked the specialist to place each metaphor within the relevant category. Then, the categorisation performed by the researchers and the categorization performed by the specialist were compared. In the comparison, the number of agreements and disagreements was determined and the reliability of the research was calculated using Miles and Huberman's formula (reliability = number of agreements / (total number of agreements + disagreements)). As a result of this calculation, a 92% reliability level was obtained for this study. The expert whose opinion was sought placed seven metaphors (worker, DNA, flower, medicine, star, mountaineer and accountant) in categories which were different from those chosen by the researchers. Thus, the reliability was equal to 78/85(78+7):0.91. According to Miles and Huberman, the desired level of reliability has been reached when the level of compliance between the expert and the researcher's evaluations is 90% or over (Miles & Huberman, 1994, as cited in Saban [12], p. 430). Finally, after defining the 85 metaphors presented by 352 students and developing the nine conceptual categories, all of the data were transferred to the SPSS statistics program. After this procedure, the number (f) and percentage (%) of participants who had used the 85 metaphors and the nine categories were calculated.

3. Findings

According to the general findings of this study, the science student teachers who participated in the study generated 85 valid metaphors with regard to the concept of a 'scientist'. Out of these 85 metaphors, 31 were used by only one student each. The number of students that used the remaining 54 metaphors ranged between two and 41 (Table 1). In this case, the average proportion of participants who used each metaphor was approximately 4%. Therefore, only 26 out of the total of 352 metaphors were developed by a group of four participants (around average) or by more than four participants (more than average) (Table 1). The remaining 59 metaphors were produced by a group of fewer than four participants (less than average). The students associated 31 of the 85 metaphors with people, four with plants and three with animals. The remaining 47 metaphors were associated with inanimate objects and abstract concepts.

The metaphors developed by the students were categorised into nine general groups (Table 2). These are:

Category 1. The scientist as a hardworking and productive figure;
Category 2. The scientist as a wise figure;
Category 3. The scientist as a figure devoting himself/herself to humanity;
Category 4. The scientist as a figure steering the society;
Category 5. The scientist as a curious figure;
Category 6. The scientist as an asocial figure;
Category 7. The scientist as a questioning-researching figure;
Category 8. The scientist as an objective figure;
Category 9. The scientist as a mad figure.

Table 1. Valid metaphors generated by students in order to explain the 'scientist' concept

No.	Metaphor name	Frequency (f)	Percentage (%)	No.	Metaphor name	Frequency (f)	Percentage (%)
1	Computer	41	11.6	44	Dynamo	2	0.6
2	Tree	22	6.3	45	Mill	2	0.6
3	Child	16	4.5	46	Treasure hunter	2	0.6
4	Sun	15	4.3	47	Traveller	2	0.6
5	Factory	15	4.3	48	Sailor	2	0.6
6	Book	14	4.0	49	Spirit	2	0.6
7	Machine	14	4.0	50	Antique	2	0.6
8	Robot	13	3.7	51	Judge	2	0.6
9	Ant	11	3.1	52	Paranoid	2	0.6
10	Bee	10	2.8	53	Atom bomb	2	0.6
11	Mother	8	2.3	54	DNA	1	0.3
12	Water	7	2.0	55	Google	1	0.3
13	Detective	7	2.0	56	Hard disk	1	0.3
14	Encyclopaedia	6	1.7	57	Flower	1	0.3
15	Journalist	6	1.7	58	Blood	1	0.3
16	Mad	6	1.7	59	Driver	1	0.3
17	Candle	5	1.4	60	Automobile	1	0.3
18	Lantern	5	1.4	61	Seed	1	0.3
19	Light	5	1.4	62	Medicine	1	0.3
20	Painter	5	1.4	63	Pilot	1	0.3
21	Technology	4	1.1	64	Servant	1	0.3
22	Lamp	4	1.1	65	Star	1	0.3
23	Torch	4	1.1	66	Fire	1	0.3
24	Soil	4	1.1	67	Window	1	0.3
25	Grass	4	1.1	68	Moon	1	0.3
26	Scales	4	1.1	69	Farmer	1	0.3
27	Internet	3	0.9	70	Cook	1	0.3
28	Library	3	0.9	71	Architect	1	0.3
29	Motor	3	0.9	72	Carpenter	1	0.3
30	Hospital	3	0.9	73	Coach	1	0.3
31	Brain	3	0.9	74	Worker	1	0.3
32	Television	3	0.9	75	Diver	1	0.3
33	Guide	3	0.9	76	Mountaineer	1	0.3
34	Artist	3	0.9	77	Police	1	0.3
35	Clock	3	0.9	78	Inspector	1	0.3
36	Cow	3	0.9	79	Critic	1	0.3
37	Camera	3	0.9	80	Soccer referee	1	0.3
38	School	2	0.6	81	Microscope	1	0.3
39	Father	2	0.6	82	Mirror	1	0.3
40	Cloud	2	0.6	83	Accountant	1	0.3
41	Doctor	2	0.6	84	Lightning	1	0.3
42	Map	2	0.6	85	Ghost	1	0.3
43	Compass	2	0.6		Total	352	100

Category 1. The scientist as a hardworking and productive figure

In this category, 16 different metaphors were used by 75 students (Table 2). "Factory" (15), "machine" (14), "ant" (11), "bee" (10), "painter" (5) and "soil" (4) were the dominant metaphors employed by groups of participants that were average-sized or larger than average. On the other hand, "artist" (3), "clock" (3), "dynamo" (2), "mill" (2), "farmer" (1), "cook" (1), "architect" (1), "carpenter" (1), "coach" (1) and "worker" (1) were metaphors that were used by groups of participants that were smaller than average. The students who developed the metaphors in this category perceived the scientist as a hardworking and productive person. According to these students, a scientist is someone who is constantly working and producing new knowledge and ideas. Some examples indicating the reasons behind the metaphors which were developed in this category are as follows:

"A scientist is like a factory in that scientists process existing knowledge and produce new knowledge and thoughts from them. Just as various products are produced in a factory, the scientist can quickly put forward various opinions and develop theories. The product produced by a scientist is knowledge. That's why we can draw a parallel between a scientist and a factory" (Student 174).

"A scientist is like a machine in that scientists work nonstop, just like a machine, and produce new knowledge. Scientists do not waste time; they work and produce all the time. They have the skill of creative thinking at the same time" (Student 36).

"A scientist is like a machine. A machine is always creating new products. Similarly, scientists always try to discover new things and to produce something new. They constantly work and do experiments" (Student 11).

"A scientist is like an ant in that scientists are constantly working and producing new knowledge without getting tired. Scientists are as hardworking as ants. Just as ants work to provide for the difficult days of winter, scientists work to provide new inventions" (Student 48).

"A scientist is like a bee in that scientists are constantly working. Just as a bee works by going from flower to flower in order to produce honey, the scientist works non-stop" (Student 39).

"A scientist is like a bee. A worker bee tries to produce honey through the pollen it has collected from various flowers. A scientist, similarly, collects information about the subjects of his/her concern, conducts research in line with this information and tries to put forward some new information" (Student 134).

"A scientist is like a painter. Scientists are similar to painters in their genuineness and eagerness to work. Just as the works of art produced by painters are the pictures they draw, the works of art produced by scientists consist of the knowledge they produce" (Student 113).

"A scientist is like soil. Fertile soil produces many things. A scientist similarly produces new knowledge by processing existing knowledge and creating a product. The products generated by the scientist are his/her scientific works" (Student 118).

Category 2. The scientist as a wise figure

In this category, nine different metaphors were used by 72 students (Table 2). "Computer" (41), "book" (14) and "encyclopaedia" (6) were the dominant metaphors used by four or more participants, which is more than the average. On the other hand, "internet" (3), "library" (3), "school" (2), "DNA" (1), "Google" (1) and "hard disk" (1) were metaphors used by fewer than four participants, which was less than average.

Table 2. The categories of metaphors generated by the students with regard to the concept of a 'scientist'

Categories		Metaphor (f)	Number of metaphors	Total frequency of metaphors	%
1	The scientist as a hardworking and productive figure	Factory (15), machine (14), ant (11), bee (10), painter (5), soil (4), artist (3), clock (3), dynamo (2), mill (2), farmer (1), cook (1), architect (1), carpenter (1), coach (1), worker (1)	16	75	21.3
2	The scientist as a wise figure	Computer (41), book (14), encyclopaedia (6), internet (3), library (3), school (2), DNA (1), Google (1), hard disk (1)	9	72	20.5
3	The scientist as a figure devoting himself/herself to humanity	Tree (22), mother (8), water (7), technology (4), motor (3), hospital (3), father (2), cloud (2), doctor (2), flower (1), blood (1), driver (1), automobile (1), seed (1), medicine (1), pilot (1), servant (1)	17	61	17.3
4	The scientist as a figure steering the society	Sun (15), candle (5), lantern (5), light (5), lamp (4), torch (4), brain (3), television (3), guide (3), map (2), compass (2), star (1), fire (1), window (1), moon (1)	15	55	15.6
5	The scientist as a curious figure	Child (16), treasure hunter (2), traveller (2), sailor (2), diver (1), mountaineer (1)	6	24	6.8
6	The scientist as an asocial figure	Robot (13), grass (4), cow (3), spirit (2), antique (2)	5	24	6.8
7	The scientist as a questioning-researching figure	Detective (7), journalist (6), police (1), inspector (1), critic (1)	5	16	4.6
8	The scientist as an objective figure	Scales (4), judge (2), soccer referee (1), camera (3), microscope (1), mirror (1), accountant (1)	7	13	3.7
9	The scientist as a mad figure	Mad (6), paranoid (2), atom bomb (2), lightning (1), ghost (1)	5	12	3.4
Total			85	352	100

The students who developed the metaphors which were placed in this category perceived a scientist as a wise person. According to these students, a scientist is usually someone who knows everything and is equipped with all kinds of scientific knowledge. The metaphors developed in relation to this category and some examples indicating the reasons behind these metaphors are as follows:

"A scientist is like a computer. Scientists are constantly conducting research and keeping the information they have obtained from this research, just like a computer. They use this information whenever necessary" (Student 60).

"A scientist is like a computer in that you get a correct answer when you ask a question of a scientist. Scientists are reliable sources of information, just like computers" (Student 72).
"A scientist is like a computer because a scientist has a memory like a computer. Scientists store information in their memory and use it whenever necessary. Scientists are always ready to upload some new information and refute the old information" (Student 97).
"Scientists are like computers in that their memories are as large as the memories of computers. Scientists receive, encode and store any information which is related to phenomena and use it correctly at the proper time" (Student 188).
"Scientists are like books in that they are essential sources of information. A scientist has a wide range of scientific knowledge in his/her own field and s/he shares this knowledge with other people when necessary" (Student 50).
"Scientists are like books in that they research, discover and store what they have learnt and they present this information to humanity. Those who do not wish to learn do not take the views of scientists into consideration and continue to live without knowledge" (Student 4).
"A scientist is like an encyclopaedia. Each page of an encyclopaedia contains different information, and a scientist's mind contains a range of different information. A scientist has certain knowledge; they know almost everything and there is nothing they cannot talk about" (Student 62).
"A scientist is like a library. Libraries contain all kinds of information. Similarly, scientists have access to a lot of information that is unknown by most people. Therefore, a scientist is similar to a library. Through a scientist, people can find the information they are looking for" (Student 195).
"A scientist is like the Internet. We can gather all kinds of information via the internet, and we can obtain all kinds of information from a scientist, too. A scientist knows everything" (Student 100).

Category 3. The scientist as a figure devoting himself/herself to humanity

In this category, 17 different metaphors were used by 61 students (Table 2). "Tree" (22), "mother" (8), "water" (7) and "technology" (4) were the dominant metaphors used by groups of average or greater than average size. On the other hand, "motor" (3), "hospital" (3), "father" (2), "cloud" (2), "doctor" (2), "flower" (1), "blood" (1), "driver" (1), "automobile" (1), "seed" (1), "medicine" (1), "pilot" (1)" and "servant" (1) were metaphors which were used by groups of participants of less than average size. The students who developed the metaphors which fell into this category perceived a scientist as a figure who has devoted himself/herself to humanity. To these students, a scientist is someone who does not think about anything but serving society and making people's lives easier. The metaphors developed in relation to this category and some examples indicating the reasons behind these metaphors are as follows:
"A scientist is like a tree. An apple tree provides fruit for humanity while a scientist serves people by providing knowledge for them" (Student 78).
"A scientist is like a mother. Mothers are self-sacrificing servants of their children. Scientists also serve society day and night with devotion, just like mothers. Scientists devote themselves to science and society just as mothers devote themselves to their children" (Student 98).
"A scientist is like water. Water is necessary and vital for all living creatures. Scientists are necessary and vital for society. Just as water vitalises plants, scientists vitalise society and work for the future of society" (Student 90).

"A scientist is like a motor. Just as a car motor makes our lives easier, a scientist makes our lives easier through his/her research. Scientists make our lives easier by finding solutions to the problems that we encounter" (Student 151).
"A scientist is like a hospital. Hospitals provide health services and emergency assistance to individuals in a society. Scientists also work for society and devote themselves to society" (Student 77).
"A scientist is like a cloud. Rain coming from a cloud turns infertile land into fertile land. Scientists are useful to society because of the knowledge they produce and provide…" (Student 20).

Category 4. The scientist as a figure steering the society

In this category, 15 different metaphors were used by 55 students (Table 2). "Sun" (15), "candle" (5), "lantern" (5), "light" (5), "lamp" (4) and "torch" (4) were the dominant metaphors used by groups of participants of average or greater than average size. On the other hand, "brain" (3), "television" (3), "guide" (3), "map" (2), "compass" (2), "star" (1), "fire" (1), "window" (1) and "moon" (1) were metaphors used by smaller-than-average groups of participants. The students who developed the metaphors which fell into this category perceived scientists as people who are enlightening and steering society. To these students, a scientist is someone who influences and enlightens society through his/her scientific ideas, and who leads or steers the society in line with certain ideals in hard times. The metaphors developed in relation to this category and some examples indicating the reasons behind these metaphors are as follows:
"A scientist is like the sun. A scientist provides light to society. When the sun disappears, there is darkness; in a similar way, a society without scientists will be subject to darkness in the future. Scientists influence people with their scientific studies and knowledge as time goes by, and lead them to new ideas" (Student 70).
"A scientist is like the sun. The sun shines on the earth and there would be no life without the sun. Scientists enlighten and influence people through their knowledge" (Student 69).
"A scientist is like a candle. Scientist enlighten and inform society. If there were no scientists at all, there would be no technology and no remedies for any diseases" (Student 137).
"A scientist is like a lamp. A lamp lets us see in darkness. Scientists enlighten us, broaden our horizons and solve our problems. Scientists enlighten illiterate or ignorant people through their knowledge" (Student 181).
"A scientist is like a torch. Just as a torch enlightens, a scientist enlightens the people around him/her and raises their awareness. Scientists uncover the truths that are hidden in the darkness and inform people about new advances in society" (Student 160).
"A scientist is like a light in that scientists investigate the incidents in the universe and thus enlighten society. Scientists lead and encourage people when they are in despair" (Student 93).
"A scientist is like the brain. The brain is the organ which manages and directs people. Scientists are those who are enlightening and directing society..." (Student 73).
"A scientist is like the television. Television directs a vast majority of the public. Scientists do have a significant influence on society through the ideas they put forward" (Student 20).
"A scientist is like a guide. Scientists guide societies towards advancement and they are the ones who prepare society for the future. A tourist guide leads tourists and enlightens them in certain subjects. A scientist, similarly, provides explanations for difficult subjects and leads societies in that sense" (Student 11).

"A scientist is like a compass. Scientists lead people just like a compass; they lead people in scientific and technological terms and make people's lives easier" (Student 129).

Category 5. The scientist as a curious figure

In this category, six different metaphors were used by 24 students (Table 2). "Child" (16) was a dominant metaphor on its own, and was used by a group of participants that was average or larger than average in size. On the other hand, "treasure hunter" (2), "traveller" (2), "sailor" (2), "diver" (1) and "mountaineer" (1) were metaphors that were used by groups of participants that were smaller than average. The students who developed the metaphors which fell into this category perceived scientists to be curious people. To these students, a scientist is like a child who has started to learn about something and is curious. The metaphors developed in relation to this category and some examples indicating the reasons behind these metaphors are as follows:

"A scientist is like a child. A six to seven year-old child looks at everything with a spirit of curiosity, asks about everything and searches for answers for all of these questions. Scientists are the same. They are always curious about incidents; they observe and produce creative ideas" (Student 192).

"A scientist is like a child. A child who has just started to talk is curious about everything around him/her. This child always asks "How come?", "How?" and "Why?" The child wants to learn about the cause and effect of phenomena... " (Student 18).

"A scientist is like a child. Both the child and the scientist ask questions. A scientist is curious, just like a child, in terms of asking questions. However, there is an important difference between the two. The child asks questions of others. The scientist, on the other hand, tries to find answers by himself/herself" (Student 19).

"A scientist is like a child. A child who has just started to learn is amazed at everything happening around him/her, and this child tries to understand what is happening. In short, the child observes everything around him/herself. Likewise, the scientist is not satisfied by what he/she has learnt and is always curious" (Student 18).

"A scientist is like a treasure hunter. A treasure hunter tries everything until s/he finds the location of the treasure s/he has been looking for. Scientists are curious, just like treasure hunters, and they are always in search of inventions. This sense of curiosity leads them to conduct research" (Student 151).

"A scientist is like a traveller. Travellers are always searching for something, and they are curious about seeing or discovering new places all the time. In this sense, I think scientists are like travellers. Scientists are curious about unknown things and they go after these unknown things" (Students 44).

"A scientist is like a sailor. Sailors sail over deep seas and cross oceans because of their curiosity. They sometimes discover new places because of this sense of curiosity. Scientists are also quite curious people. Just like the sailors..." (Student 81).

Category 6. The scientist as an asocial figure

In this category, five different metaphors were used by 24 students (Table 2). "Robot" (13) and "grass" (4) were the dominant metaphors used by groups of participants that were average or larger than average in size. On the other hand, "cow (3)", "spirit (2)" and "antique (2)" were the metaphors used by smaller-than-average groups of participants. The students who developed the

metaphors which fell into this category perceived scientists as asocial people. To these students, a scientist is an isolated person who is always thinking and dealing with his/her own work and who lives alone. The metaphors that were developed in relation to this category and some examples indicating the reasons behind these metaphors are as follows:

"A scientist is like a robot. Robots work in line with a program. Everything in scientists' lives is monotonous, just like robots. Scientists are different from normal people; they work in line with their intentions. They are usually isolated from life" (Student 141).

"A scientist is like a robot. Scientists' lives are usually monotonous; they do not have any social life. They are always thinking about something. Their relationship with outside world is limited. They are emotionless people. They are similar to robots in that sense" (Student 23).

"A scientist is like grass. Scientists do not engage in any social activities. They do not take part in any social activities. They are only interested in their own work. Therefore, I think they are similar to grass" (Student 8).

"A scientist is like a soul, in that scientists are asocial people who are always thinking about something. They hang around, just like a soul, and they are disconnected from society" (Student 62).

"A scientist is like an antique. They are a rare type. I think that scientists are asocial people who have detached themselves from society. A scientist is a person who sits in a dusty room and thinks all the time in an attempt to invent something new" (Student 24).

Category 7. The scientist as a questioning-researching figure

In this category, five different metaphors were used by 16 students (Table 2). "Detective" (7) and "journalist" (6) were the dominant metaphors used by average or larger-than-average groups of participants. On the other hand, "police" (1), "inspector" (1) and "critic" (1) were metaphors used by smaller-than-average groups of participants. The students who developed the metaphors which fell into this category perceived scientists as questioning people who conduct research. To these students, a scientist is a person who questions and researches phenomena according to their cause and effect relationship. The metaphors developed in relation to this category and some examples indicating the reasons behind these metaphors are as follows:

"A scientist is like a detective. Scientists examine incidents just like detectives, down to the last detail, and work carefully until they reach the best result. Scientists question incidents according to the cause and effect relationship, focus on details and consider all of the possibilities in order to obtain reliable results" (Student 126).

"A scientist is like a journalist. Journalists always look for fresh news. Journalists search for reasons; they search for the unknown side of an incident. Scientists also question and research incidents and they use scientific methods during their research. Scientists examine the unknown sides of an incident with a sceptical approach" (Student 46).

Category 8. The scientist as an objective figure

In this category, seven different metaphors were used by 13 students (Table 2). "Scales" (4) was a dominant metaphor on its own, and was used by an average or larger-than-average group of participants. On the other hand, "judge" (2), "football referee" (1), "camera" (3), "microscope" (1), "mirror" (1) and "accountant" (1) were metaphors used by a smaller-than-average group of participants. The students who developed metaphors which fell into this category perceived

scientists as objective people. To these students, a scientist is someone who evaluates scientific events in an objective manner. Some of the metaphors developed by these students and some examples indicating the reasons behind these metaphors are as follows:

"A scientist is like a set of scales. A set of scales is a very sensitive device which weighs everything correctly. Likewise, scientists are sensitive and objective in their evaluation and research concerning scientific events. They evaluate everything in the light of science. Scientists, in their studies, do not value feelings but scientific facts. It is inevitable that a scientist will see events from an objective viewpoint" (Student 81).

"A scientist is like a judge. Questioning the truths underlying phenomena from an objective viewpoint is characteristic of both the judge and the scientist. Scientists see events from a reasonable and objective viewpoint according to their cause and effect relationship" (Student 158).

Category 9. The scientist as a mad figure

In this category, five different metaphors were used by 12 students (Table 2). "mad" (6) was a dominant metaphor on its own and was used by a group of participants that was average or larger than average. On the other hand, "paranoid" (2), "atom bomb" (2), "lightning" (1) and "ghost" (1) were metaphors that were used by smaller-than-average groups of participants. The students who developed the metaphors which fell into this category perceived scientists as mad people. To these students, a scientist is a mad person who deals with dangerous work and talks to themselves. Some of the metaphors which were developed in relation to this category and some examples indicating the reasons behind these metaphors are as follows:

"A scientist is like a mad person because I do not think that scientists are normal people. I think that their lives are quite different from other people's lives. A scientist is busy talking to himself/herself, a scientist does anything s/he wants, and a scientist deals with strange experiments and tries to prove everything. In fact, I am afraid of such people" (Student 155).

"A scientist is like an atom bomb. An atom bomb is effective and very different from other bombs. Likewise, scientists are abnormal people who are different from other people. We never know what they actually do because they usually deal with extraordinary things. They can harm the world through their dangerous experiments. That's why they are usually crazy people" (Student 60).

4. Discussion and conclusions

The purpose of this research was to examine science student teachers' concept of a 'scientist' through metaphor analysis. The metaphors developed by the science student teachers in relation to the concept of a 'scientist' were classified according to nine conceptual categories. According to these categories, most of the science student teachers perceived scientists as being hardworking and productive figures (category 1) (21.3%), wise (category 2) (20.5%), devoted to humanity (category 3) (17.3%) and as being those who steer society (category 4) (15.6%). These categories mentioned above were represented by approximately 75% of the participants. On the other hand, approximately 25% of the participants saw scientists as curious (category 5) (6.8%), asocial (category 6) (6.8%), questioning-researching (category 7) (4.6%), objective (category 8) (3.7%) or mad (category 9) (3.4%). The results of this study indicate that science student teachers' perceptions of scientists are usually positive. In addition, the participants believed some

myths about scientists. For example, the category of the scientist as an objective figure reflects one of these myths. It is desirable for both the scientist and scientific knowledge to be objective. Scientific knowledge has to be independent of the scientist, expressed as it is and remain unaffected by the personal opinions of the scientist. However, as the scientist producing this knowledge is a human, it may be quite difficult for a scientist to detach himself/herself from his/her personal value judgments. Nevertheless, the main target is for the scientist to be as objective as possible and to avoid the effects of cultural factors. There are a number of studies that have documented students' and teachers' misconceptions concerning scientists and the nature of science [15, 33-36]. The repetition of myths which are similar to those mentioned in previous studies indicates that students' perceptions of science and scientists are fairly stabile and resistant to change.

Furthermore, the participants held negative and stereotypical perceptions of scientists. For example, the categories of scientists as asocial (category 6) and mad (category 9) figures reflect the participants' negative and stereotypical perceptions of scientists. Stereotypical perceptions of scientists which were found among the students in research in which methods such the DAST and word association tests were used [13,-15, 17, 18, 23, 37] were likewise found in this research in which metaphor analysis was used. Many researchers have reported that science course books and teachers may have an influence upon science student teachers' perceptions of science and scientists [21, 38]. The myths and stereotypical perceptions of the science student teachers who participated in this study with regard to scientists influenced their attitudes towards science and scientists. Furthermore, these participants will consciously or unconsciously influence the attitudes of their own students with regard to science and scientists when they become teachers in the future. In this sense, the nature of science, the characteristics of scientists and how a scientist develops and uses knowledge should be comprehensively emphasised in the undergraduate science syllabus and related courses. There is a need for effective strategies of instruction [39-44] which could change students' ideas with regard to stereotypes.

In conclusion, the findings of this research provide significant evidence with regard to the use of metaphors as powerful tools in revealing individual science student teachers' perceptions of scientists. Furthermore, metaphors are somehow limited. It is impossible for a metaphor to fully encompass or convey a concept, and so it can only produce a one-sided viewpoint. Some metaphors, on the other hand, can only convey a limited meaning and can therefore reflect only one part of a specific complicated situation [1, 45-47]. Metaphors usually simplify reality and avoid keep complicated details in order to create a familiar, comprehensible and consistent image [1]. In terms of minimising the aforementioned limitations of metaphors, there is a need for further research which will analyse the factors influencing science student teachers' perceptions of science and scientists through metaphors. In parallel with the results that have been obtained from research, the following suggestions regarding the science education teachers may be made:

1. During their pre-service training, student teachers should be provided with an educational environment that will lead them to develop positive perceptions about the concepts of science and scientists;
2. The courses undertaken during their education should focus on the nature of science and the working style of scientists in an effective manner;
3. Instructors should focus on the history of science, important scientific discoveries and the lives of scientists in an effective manner so that student teachers can develop positive perceptions about scientists.

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