

An Examination of Pre-Service Primary School Teachers' Comprehension of The Concept of Physics Through Metaphors

Işil Aykutluⁱ
Hacettepe University

Abstract

The aim of this study is to lay bare pre-service primary school teachers' perception of "physics" through metaphors. The study was realized with the participation of 38 freshmen pre-service teachers taking General Physics at a public university. Data of the study were obtained with participants filling the blanks in the following sentence: "In my opinion physics is like a/an ... because ...". The study was designed in phenomenological method, which is one of the qualitative research methods. In the analysis of data, content analysis method was used. As a result of the obtained data, it was determined that pre-service primary school teachers constructed 31 valid metaphors in relation to the concept of physics. It was determined that the highest frequency among these metaphors belongs to the "nightmare". Metaphors generated by the pre-service teachers were grouped under seven different conceptual categories in terms of the meanings they contain. As a result of the study, it was determined that most of the metaphors generated by the pre-service teachers consist of a negative perception.

Key words: Pre-service primary school teachers, physics, metaphor.

ⁱ **Işil Aykutlu** Dr., Physics Education Department at The Department of Mathematics and Science Education, Hacettepe University, Ankara, Turkey

Correspondence: aykutlu@hacettepe.edu.tr

Introduction

Metaphor etymologically comes from the Greek word “*metapherein*,” and it is formed by the combination of *meta* (to change) and *pherein* (to bear) (Levine, 2005). Metaphors, which are linguistic tools that combine two objects or concepts, are accepted as a symbolic language structure that can be used to combine two different ideas or concepts in order to compare or transit from one life to another. Metaphors are presented as words, verbs, or adjectives in daily language (Palmquist, 2001). Enabling a new phenomenon to be understood or explained by transferring a known case to a case whose meaning is unknown, metaphors are one of the most powerful mental tools that shape, direct, and control our thoughts (Morgan, 1980; Oxford et al., 1998; Saban, 2004; Yob, 2003). Used to define unclear or difficult to understand thoughts besides making thought open, comprehensible, and enlightening, metaphors can be defined as comparing different things for different reasons and effects (Çelikten, 2006) or understanding or experiencing one thing through another (Lakoff & Johnson, 2005). Metaphors enable individuals to reflect their thoughts and expectations regarding the present and the future, and they not only reveal thoughts but also construct perception and comprehension, and they make it easier for individuals to comprehend and understand events better (Arslan and Bayrakçı, 2006; Lakoff and Johnson, 2003; Levine, 2005). Having a significant place in learning process, metaphors play an important role in understanding difficult to understand topics and keeping them in mind (Altıntaş, Kahraman, Ülger and Altıntaş, 2014; Arslan & Bayrakçı, 2006; Çelikten, 2006; Fretzin, 2001; Goldstein, 2005; Hanson, 1993; İbret & Aydınözü, 2011). Just as in analogies, metaphors denote a way of thinking of and seeing the world, helping us comprehend the world as they try to explain a concept by using another that has a similarity to that one (Çelikten, 2006). The difference between analogy and metaphor is that the way they use the emphasis in comparison differently. Analogies openly compare to different field and express the qualities of these structures. On the other hand, metaphors make an indirect comparison between two different fields and they emphasize the unrelated or relative qualities of two different fields in a closed manner (Duit, 1991). In order for a phenomenon to be accepted as metaphor, it should have a topic, a source, and qualities that can be attributed to the topic of the metaphor from the source of the metaphor (Forceville, 2002). In a metaphorical relationship, the *source* of the metaphor functions as a filter in explaining or comprehending the *topic* of the metaphor in a different way. For instance, in the expression “A teacher is like a gardener because just as a gardener deals one by one with the young plants he is growing a teacher should take into consideration individual differences in a class,” the topic of the metaphor is “the teacher” and the source is “the gardener.” The quality attributed to the topic from the source is put forth in the following expression “just as a gardener deals one by one with the young plants he is growing a teacher should take into consideration individual differences in a class” (Saban, 2004).

Metaphors can be abstract or concrete just as they can be positive or negative (Semerci, 2007). Students’ reluctance towards school or their fear of school can be overcome by using metaphors in education (Osborn, 1997). Teachers can create creative and explorative learning environments by using metaphors; this would improve students’ imagination and they can even use metaphors to determine their thoughts about concepts (Saban, 2004; Sanchez, Barrerio & Maojo, 2000). Students’ personal perception related to phenomena can also be revealed by using the metaphors students come up with (Saban, 2004).

It is seen that there have been numerous studies on metaphors in various fields since the 1980s. Some of these studies are related to education. It has been expressed in various studies (Aydın & Pehlivan, 2010; Şengül, Katrancı & Cantimer, 2014) that metaphors can be used in planning, education, program designing, promoting learning, and in improving creative thinking. Moreover, it can be seen that metaphor is frequently used in education research in determining perceptions of teachers, pre-service teachers and students (Altıntaş, Kahraman, Ülger & Altıntaş, 2013; Arslan & Bayrakçı, 2006; Cerit, 2006; Bahadır & Özdemir, 2012; Clarken, 1997; Ocak & Gündüz, 2006; Saban, 2004; Saban, 2008; Saban, 2009; Saban, Koçbeker, & Saban, 2006; Sadıoğlu & Uzun, 2014; Şengül, Katrancı & Cantimer, 2014; Usta & Ültay, 2015; Vadeboncoeur, & Torres, 2003; Yalmanlı & Aydın, 2013; Yücel, Koçak & Cula, 2010). However, there is no study in literature that examines pre-service teachers’ perception of the concept of physics with the help of metaphors. A positive science that

examines matter, energy, and the reciprocal effects of matter, physics focuses on principal laws of the universe and is based on experimental observation and qualitative measurements in order to understand natural phenomena (Ertaş, 1993; Serway, 1995). Physics has a significant place in our lives because it enables us to explore known and unknown phenomena, draws students to scientific thinking and research (Nuhoğlu & Yalçın, 2004; Sarı, 2013). Students usually consider physics classes to be difficult, boring, uninteresting, and full of unnecessary information (Angel, Guttersrud, Henriksen & Isnes, 2004; Baubeng, Conner & Winter, 2015; Reid & Skryabina, 2002; Tekbryk & Akdeniz, 2012; Whitelegg & Perry, 1999). It is seen that students gain their first knowledge of concepts related to physics during their formal education with their primary school teacher. It is believed that teachers' perception of the classes they teach play an important role in the design of the teaching environment. No matter what the course is, teachers have the responsibility to make sure students love the course, learn it, and understand its importance. Negative perception against a course would significantly affect success in that particular course (Şahin, 2013). Taking all of these into consideration, it is believed that laying bare pre-service primary school teachers' perception of the concept of physics will contribute to the field.

This study was realized in order to lay bare pre-service primary school teachers' perception of the concept of "physics" through metaphors. Within this general framework, answers were sought for the following sub problems:

- What are the metaphors pre-service primary school teachers construct related to the concept of physics?
- Under what categories can these metaphors be grouped in terms of their similarities?

Methodology

Research Design and Participants

The study was designed in phenomenological method, which is one of the qualitative research methods. Phenomenology pattern focuses on phenomena which exist in various forms such as experience, perception, and concepts that we are aware of but cannot fully comprehend in detail (Yıldırım & Şimşek, 2013). In this particular study, pre-service primary school teachers' perception of the concept of physics was tried to be determined under conceptual categories.

The study was realized with the participation of 38 freshmen pre-service teachers taking General Physics at a public university. Metaphors of two pre-service teachers were discarded on the grounds that the explanations were insufficient. Thus, answers of 36 pre-service teachers were taken into account. In phenomenological studies, the aim is not to reach a great number of people but the focus on the quality of information obtained from individuals (Baş & Akturan, 2008). In this respect, instead of making sure many people participated in the study, voluntary participation was encouraged and prioritized.

Research Instrument

In determining the data gathering tool, national and international literature was reviewed in order to see how metaphors are used in determining perception. Perception of the participating pre-service primary teachers was gathered by using a metaphor form. Whether this metaphor form, which consists of the following expression, "In my opinion physics is like a/an ... because ..." meets the criteria was checked by getting opinion from two experts from the field of physics education. Then, a pilot study was conducted with the participation of 10 pre-service teachers. As a result of this pilot study, it was determined that pre-service teachers have no problem generating metaphors, and it was decided that metaphor form should be used in the study.

Application

Application was done at the end of the “General Physics” course that pre-service primary school teachers take during their freshman year. First of all, they were given information about the application, and then metaphor examples on different topics were introduced; they were also given information as to how they can construct metaphors. Pre-service teachers were given one class hour to complete the task. Pre-service teachers were asked to explain their thoughts by using the sentence given in the form and focusing on one single metaphor. At the end of the application, metaphors and explanations that form the data of this study were obtained.

Data Analysis

In the study, metaphors obtained with the data gathering tool were analyzed through content analysis. In content analysis data are processed thoroughly so that unnoticed concepts or themes would be revealed; first of all data are conceptualized, then these are organized in a meaningful and logical way, and thus themes explaining the data are determined (Yıldırım & Şimşek, 2013).

Metaphors about the concept of physics formulated by pre-service teachers were analyzed in five stages (Saban, 2009). All operations done during analysis are given in detail below

1. **Coding and Sorting:** In the analysis of data, firstly a tentative alphabetical list was done with the metaphors formulated by pre-service teachers. Then, these metaphors were coded and checked whether they are expressed properly and whether the explanations are done properly. For example, punishment, torture, nightmare, magic box, etc. At this stage, metaphors of two pre-service teachers were not taken into consideration as they did not include the necessary explanation.

2. **Picking Sample Metaphor Image:** Revising the valid metaphors, a sample metaphor list was formed in order to gather metaphors under a certain category and make the data analysis process and interpretations valid.

3. **Developing Categories:** Metaphors formed by pre-service teachers were examined taking into consideration the explanations they provided; and they were tried to be gathered under a category by grouping common ones. To this end, each metaphor formed by pre-service teachers was analyzed in terms of the theme of the metaphor (physics), the source of the metaphor, and the relationship between the source of the metaphor and its theme. Conceptual categories which were formed by the classification of the metaphors were named under themes by the researcher.

4. **Validity and Reliability:** In qualitative studies, the most important indicator of validity is a detailed report of the data and reached conclusions (Yıldırım & Şimşek, 2013). In this study, too, data analysis process was explained in detail in order to provide validity. In order to secure the validity of the study, the first three steps of data analysis were repeated at two different intervals by the researcher and these were compared to the metaphors. Then, two experts on physics education were consulted as to whether the metaphors within the conceptual categories represent these categories. Reliability of the study was calculated by using reliability formula ($\text{Reliability} = \frac{\text{consensus}}{\text{consensus} + \text{dissensus}}$) developed by Miles & Huberman (1994), and it was found to be 0.90.

5. **Transferring Data to Digital Environment:** At this stage, metaphors formed by pre-service teachers and their conceptual categories were transferred to digital media, and their frequency and percentages were calculated.

Findings

When the findings of this study, in which pre-service primary school teachers' perception of "physics" were examined through metaphors, were examined, it was seen that pre-service teachers generated 31 different and valid metaphors concerning the concept of physics. These metaphors were grouped under seven different conceptual categories according to their meanings (Table 1).

Table 1. Conceptual categories of pre-service physics teachers' metaphors for the concept of physics

Conceptual Categories	Total number of metaphors in category f (%)
Difficult Physics	9 (29%)
Horrible Physics	7 (22,6%)
Painful Physics	5 (16,1%)
Mysterious Physics	5 (16,1%)
Useful Physics	4 (12,9%)
Impossible Physics	4 (12,9%)
Disliked Physics	2 (6,5%)

When Table 1 is examined, it can be seen that five of the conceptual categories consist negative perception (Table 2). Pre-service teachers' metaphors with negative perception (74.2%) were gathered under the following conceptual categories: *difficult physics* (29%), *horrible physics* (22.6%), *painful physics* (16.1%), *impossible physics* (12.9%), and *disliked physics* (6.5%). When the conceptual categories containing negative perceptions were examined, it was seen that the category with the most metaphors is *difficult physics* (29%). When the metaphors in this category were examined, it was determined that pre-service teachers tried to express their perception with such metaphorical images as *unknown language* (1, 3,2%), *a deep well* (1, 3,2%), *a complex world* (1,3,2%), *a complex yarn* (1, 3,2%), *a labyrinth* (1, 3,2%), *a discordant picture* (1, 3,2%), *an intense mixture* (1, 3,2%), and *a tough climb* (1, 3,2%).

Table 2. Pre-service teachers' metaphors containing negative perception and the categories

Conceptual Categories	Name of metaphor	Number of metaphors f (%)	Total number of metaphors in category f (%)
Difficult Physics	Unattainable task	1 (3,2%)	9 (% 29)
	Unknown language	1 (3,2%)	
	Bottomless pit	1 (3,2%)	
	Complex world	1 (3,2%)	
	Tangled yarn	1 (3,2%)	
	Labyrinth	1 (3,2%)	
	Discordant Picture	1 (3,2%)	
	A dense mixture	1 (3,2%)	
	Steep climb	1 (3,2%)	

Horrible Physics	A drowning pool	1 (3,2%)	7 (%22,6)
	Nightmare	5 (16,1%)	
	Horror movie	1 (3,2%)	
Painful Physics	Cayenne pepper	1 (3,2%)	5 (16,1%)
	Punishment	1 (3,2%)	
	Toothache	1 (3,2%)	
	Torture	1 (3,2%)	
	Cactus	1 (3,2%)	
Impossible Physics	A fast flowing river that one wants to pass without a bridge	1 (3,2%)	4 (12,9%)
	Wasteland	1 (3,2%)	
	A road full of impossibilities	1 (3,2%)	
Disliked Physics	Behind closed doors	1 (3,2%)	2 (6,5%)
	A disliked friend	1 (3,2%)	
	A poor orphan	1 (3,2%)	
Total		23 (74,2%)	

Some of the metaphors with negative perceptions and explanations by pre-service teachers are given below (S:Student, #: student number)

S18: *“To me, physics is like a nightmare, because just like a nightmare, topics of physics bother and overwhelm you.”*

S6: *“To me physics is like cactus because whenever I think of something related to physics I feel like being needled by the thorns of a cactus.”*

S16: *“In my opinion, physics is like a road full of impossibilities, because it deals with problems that seem hard or impossible to solve.”*

S27: *“For me, physics is like a waste land because no matter how hard I study, I never get it nor can I succeed.”*

S38: *“For me, physics is like an orphan because it is a complete torture; there is no way to understand it. Even mathematics can be liked but not physics. You wouldn’t love it even if it were your child.”*

When pre-service teachers’ metaphors containing a negative perception towards physics, categories related to these metaphors, and the necessary explanations were examined, it can be said that they consider physics to be a field that is hard, difficult to understand, scary, painful, and disliked.

When findings were examined, it was seen that pre-service teachers’ metaphors containing a positive perception were gathered under the categories mysterious physics 5 (16,1%) and useful physics 4 (12,9%) (Table 3). It was determined that the most metaphors containing a positive reception towards physics were under the mysterious physics category (16,1%). It was also determined that the most frequently repeated metaphor in this category is puzzle 2 (6,4%).

Table 3. Pre-service teachers’ metaphors containing a positive perception and the categories

Categories	Name of metaphor	Number of metaphors f (%)	Total number of metaphors in category f (%)
Mysterious physics	Puzzle	2 (6,4%)	5 (16,1%)
	Endless tunnel	1 (3,2%)	
	Bottomless pit	1 (3,2%)	
	Magic box	1 (3,2%)	
Useful Physics	Water in the desert	1 (3,2%)	4 (12,9%)
	Understanding the world	1 (3,2%)	
	Broccoli	1 (3,2%)	
Total		7 (22,6%)	

It was determined that pre-service teachers used *puzzle* (2, 6,4%), *endless tunnel* (1, 3,2%), *bottomless pit* (1, 3,2%), and *magic box* (1, 3,2%). It can also be seen that under the “useful physics” category, they used *water in the desert* (1, 3,2%), *understanding the world* (1, 3,2%), and *broccoli* (1, 3,2%).

Some of the metaphors with positive perceptions and explanations by pre-service teachers are given below (S:Student, #: student number)

S3: “For me physics is like a bottomless pit because the more you get into it, the more it draws you in. It always consists something new, and it always has something mysterious.

S17: “For me physics is like a magic box because just like a magic box it deals with things that surprise people.”

S1: “To me, physics is like broccoli because although it is not liked by many people it is highly useful.”

When pre-service teachers’ metaphors containing a positive perception and their explanations were examined, it was seen that pre-service teachers find physics useful although they do not like it, they believe that physics can reveal the unknown, and that they perceive of it as a mysterious field.

Discussion and Conclusion

In this study, it was determined that pre-service teachers generated 31 different metaphors related to physics. 24 of these metaphors consisted of a negative perception, and only seven of them consisted of a positive perception. In a similar study about pre-service science teachers by Sadoğlu & Uzun (2014), it was also determined pre-service had a negative perception against physics. It can be seen that pre-service teachers’ metaphors with negative perception are gathered under such categories as difficult physics, horrible physics, painful physics, impossible physics, and disliked physics. It was revealed that the number of metaphors with negative perception in the difficult physics category is higher compared to other conceptual categories. This result can show that pre-service teacher consider physics to be a difficult concept. Another result obtained in the study is that “nightmare” as a metaphor was the most frequently repeated one within conceptual categories. All these results show that pre-service teachers perceive physics as a difficult to succeed in, difficult to understand, complex, scary, painful, and dislike field. In the studies conducted on this topic, it was determined that pre-service teachers do not like physics in which scientific knowledge is taught (Kapucu, 2014). Moreover, many studies also reveal that physics is considered to be a difficult to understand, boring,

and disliked as a class (Ornek, Robinson & Haugan, 2008; Redish, 1994). The reasons for this may be the fact that students have difficulty drawing relations between concepts, that they have deficiency in mathematical operations, and that physics mainly consists of abstract concepts (Aycan & Yumuşak, 2003; Gill, 1999; Ornek, Robinson & Haugan, 2008; Orton and Roper, 2000; Şahin & Yağbasan, 2012). It is believed that students must have had negative experience related to physics since metaphors reflect people's experience and their conditions (Lakoff & Johnson, 2003). It was seen that pre-service teachers who participated in this study were given physics course in the spring semester of their freshman year and only for two hours. Moreover, it was determined that there are too many learning outcomes in the curriculum. It is believed that revising the curriculum and providing exercises that are related to daily life would help students develop a more positive attitude towards physics as well as enable a meaningful learning (Usta & Ültay, 2015). When the conceptual categories in which metaphors of pre-service teachers with positive perception are given were examined, it was also determined that pre-service teachers think of physics as useful although they dislike it, that they see it as a mysterious field, and that they believe that it would reveal the unknown. This result shows that some of the pre-service teachers may have a positive attitude towards physics. In other studies, it was indicated that metaphors can be used to determine the thoughts and attitudes towards a concept (Doğan, 2014; Soysal & Afacan, 2012).

This study tried to describe pre-service primary school teachers' perceptions of physics through metaphors. As a result of the research done, it was determined in this study also that metaphors could be used in determining pre-service teachers' perceptions. It's been believed that primary school teachers play a significant role during formal education in shaping students' knowledge of physics and helping them develop a positive attitude towards physics. Therefore, similar studies on different topics may be done with pre-service primary school teachers. It is also believed that metaphors that are formed to describe perceptions of physics, can be guides for physics teachers in showing them what to do for a better physics education.

References

- Altıntaş G., Kahraman E., Ülger E. & Altıntaş S. U. (2013). Science' course and 'science teachers' metaphors developed concepts of science teachers. *The Fifth International Congress of Educational Research, 6 - 9 June, Çanakkale, Turkey*, 799-810.
- Altıntaş G., Kahraman E., Ülger E. & Altıntaş S. U. (2014). The metaphors developed by students for the concepts in 'the particulate structure of matter' unit of science and technology course. *Journal of Research in Education and Teaching*, 3(3), 271-282.
- Angell, C., Guttersrud, Ø., Henriksen, E. K.. & Isnes A. (2004). Physics: Frightful, but fun pupils' and teachers' views of physics and physics teaching. *Science Education*, 88(5), 683-706.
- Arslan, M.M. & Bayrakçı, M (2006). Metaforik düşünme ve öğrenme yaklaşımının eğitim-öğretim açısından incelenmesi [An examination of metaphoric thinking and learning approach in terms of education]. *Milli Eğitim Dergisi*, 171, 100-108.
- Aycan, Ş. & Yumuşak, A. (2003). Lise fizik müfredatındaki konuların anlaşılma düzeyleri üzerine bir araştırma [A study on the comprehension levels of topics in the high school physics curriculum]. *Milli Eğitim Dergisi*, 159, 171-180.
- Aydın, İ.S. & Pehlivan, A. (2010) . The metaphors that turkish teacher candidates use concerning "teacher" and "student" concepts. *Turkish Studies, International Periodical For The Languages, Literature And History Of Turkish Or Turkic*, 5(3), 818-842.
- Bahadır, E. & Özdemir, A. Ş. (2012). 7th grade primary school students mental images about the concept of mathematic. *International Journal of Social Science Research*, 1(1), 26-40.

- Baubeng, I. Conner, L. & Winter, D. (2015). The lack of physics teachers: “Like a bath with the plug out and the tap half on”. *American Journal of Educational Research*, 3(6), 721-730.
- Baş, T. & Akturan, U. (2008). *Nitel araştırma yöntemleri: Nvivo 7.0 ile nitel veri analizi*. Ankara: Seçkin Yayıncılık. [Qualitative research methods: Qualitative data analysis with Nvivo 7.0. Ankara: Seçkin Publishing House]
- Cerit, Y. (2006). School metaphors: The views of students, teachers and administrators *Educational Sciences: Theory & Practice*, 6(3), 669-699.
- Clarcken, R. H. (1997). *Five metaphors for educators*. Paper presented at the annual meeting of the American Educational Research Association, Chicago.
- Çelikten, M. (2006). Culture and teacher metaphors used in educational system . *Erciyes University, Journal of Social Sciences Institute*, 21(2), 269-283.
- Doğan, D. (2014). Analysis of the school concept through the perspectives of candidate teachers via metaphors. *Journal of Theoretical Educational Science*, 7(3), 361-382.
- Duit, R. (1991) On the role of analogies and metaphors in learning science. *Science Education*, 75(6), 649-672.
- Ertaş, İ. (1993). *Denel fizik dersleri*. İzmir: Ege Üniversitesi Basımevi [Empiric Physics Courses. İzmir: Ege University Press].
- Fretzin, L. (2001). *Metaphors in teaching*. Retrieved 16.02.2016, from <http://lrs.ed.uiuc.edu/students/fretzin/EPL11q5Metaphors.htm>
- Forceville, C. (2002). The identification of target and source in pictorial metaphors. *Journal of Pragmatics*, 34(1), 1–14.
- Gill, P. (1999). The physics/maths problem again. *Physics Education*, 34(2), 83-87.
- Goldstein, L. S. (2005). Becoming a teacher as a hero’s journey: using metaphor in preservice teacher education. *Teacher Education Quarterly*, 32(1), 7–24.
- Hanson, L. (1993). Affective response to learning via visual metaphor. *Annual Conference of the International Visual Literacy Association, October 13-17*, New York.
- İbret B. U. & Aydınöz D. (2011). The metaphors developed by elementary school-second stage students on the concept of ‘world’. *Kastamonu Education Journal*, 19(1), 85-102.
- Kapucu, S. (2014). Salient beliefs of pre-service primary school teachers underlying an attitude “liking or disliking physics”. *Science Education International*, 25(4), 437-458.
- Lakoff, G. & Johnson, M.(2003). *Metaphors we live by*. London: The University of Chicago Press.
- Lakoff, G. & Johnson, M. (2005). *Metaforlar: Hayat, anlam ve dil* (Çeviri G. Y. Demir). İstanbul: Paradigma.
- Levine, P.M. (2005). Metaphors and images of classrooms. *Kappa Delta Pi Record*, 41(4), 172-175.
- Miles, M. B. & Huberman, A. M. (1994). *Qualitative data analysis* (second press). Thousand Oaks, CA: SAGE.

- Morgan, G. (1980). Paradigms, metaphors, and puzzle solving in organizational analysis. *Administrative Science Quarterly*, 25, 606-622.
- Nuhoğlu, H. & Yalçın, N. (2004). The development of attitude scale for physics laboratory and the assessment of pre-service teachers' attitudes towards physics laboratory. *Gazi University Journal of Kirsehir Education Faculty*, 5(2), 317-327.
- Ocak, G. & Gündüz, M. (2006). The comparison of pre-service teachers' metaphors about the teacher-profession before and after the 'introduction to teacher-profession' course. *Afyon Kocatepe Üniversitesi Sosyal Bilimler Dergisi*, 8(2), 293-311.
- Ornek, F., Robinson, W.R. & Haugan, M.P. (2008). What makes physics difficult? *International Journal of Environmental & Science Education*, 3(1), 30-34.
- Orton, T. & Roper, T. (2000). Science and mathematics: A relationship in need of counselling? *Studies in Science Education*, 35, 123-154.
- Osborn, M. (1997). The play of metaphors. *Education*, 118(1), 84-87.
- Oxford, R., Tomlinson, S., Barcelos, A., Harrington, C., Lavine, R., Saleh, A. & Longhini, A. (1998). Clashing metaphors about classroom teachers: Toward a systematic typology for the language teaching field. *System*, 26(1), 3-50.
- Palmquist, R.A. (2001). Cognitive style and users' metaphors for the web: an exploratory study. *Journal of Academic Librarianship*, 27(1), 24-32.
- Reid, N. & Skryabina, E.A. (2002). Attitudes towards physics. *Research in Science and Technological Education*, 20(1), 67-81.
- Redish, E. F. (1994). The implications of cognitive studies for teaching physics. *American Journal of Physics*, 62, 796-803.
- Saban, A. (2004). Entry level prospective classroom teachers' metaphors about the concept of "teacher". *The Journal of Turkish Educational Sciences*, 2(2), 131-155.
- Saban, A. (2008). Metaphors about school. *Educational Administration: Theory and Practice*, 55, 459-496.
- Saban, A. (2009). Prospective teachers' mental images about the concept of student. *The Journal of Turkish Educational Sciences*, 7(2), 281-326.
- Saban, A., Koçbeker, B.N., & Saban, A. (2006). An investigation of the concept of the teacher among prospective teachers through metaphor analysis. *Educational Sciences: Theory & Practice*, 6(2), 509-522.
- Sadoğlu, G. P. & Uzun, S. (2014). Identifying pre-service science and technology teachers' perceptions related to the concept of physics through metaphors. *International Journal of Educational Research and Technology*, 5(1), 36-41.
- Sarı, M. (2013). The effect of experimental teaching of physics topics in the study of student success and challenges of teachers. *Journal of Research in Education and Teaching*, 2(3), 143-147.
- Sanchez, A., Barreiro J. M. & Maojo V. (2000). Design of virtual reality systems for education: A cognitive approach. *Education and Information Technologies*, 5(4), 354-362.

- Semerci, Ç. (2007). A view to the new primary school curricula with the metaphors relating to “curriculum development. *Cumhuriyet University The Journal of Social Sciences*, 31(1), 139-154.
- Serway, R. A. (1995). *Physics for scientists & engineers wiht modern physics*. Third edition. Translation Editor, Kemal Çolakkoğlu, Palme Publishing House.
- Soysal, D. & Afacan, Ö. (2012). Metaphors used by primary school students to describe “science and technology lesson” and “science and technology teacher”. *Mustafa Kemal University Journal of Social Sciences Institute*, 9(19), 287-306.
- Şahin, B. (2013). Teacher candidates’ metapforic perceptions related with “mathematics teacher”, “mathematics”and “math lesson” concepts. *Mersin University Journal of the Faculty of Education*, 9(1), 313-321.
- Şahin, E., & Yağbasan, R. (2012). Determining which introductory physics topics pre - service physics teachers have difficulty understanding and what accounts for these difficulties. *European Journal of Physics* , 33, 315-325.
- Şengül, S., Katrancı, Y. & Cantimer, G.G. (2014). Metaphor perceptions of secondary school students about “mathematics teacher”. *The Journal of Academic Social Science Studies*, 25(1), 89-111.
- Tekbıyık, A. & Akdeniz, A.R. (2010). A contemporary physics attitude scale for secondary school students: development, validity and reliability. *Journal Turkish Science Education* , 7(4), 134-144.
- Usta, N. D. & Ültay, N. (2015). A comparative study of preschool student teachers“chemistry” metaphors. *The Black Sea Journal of Social Sciences, Special Issue of Hüseyin Hüsnü Tekişık*, 1(7), 163-177.
- Vadeboncoeur, J. A., & Torres, M. N. (2003). Constructing and reconstructing teaching roles: A focus on generative metaphors and dichotomies. *Discourse: Studies in the Cultural Politics of Education*, 24(1), 87-103.
- Whitelegg, E. & Parry, M. (1999). Real-life contexts for learning physics: meanings, issues and practice. *Physics Education*, 34, 68-72.
- Yalmancı, S. G. & Aydın, S. (2013). Pre-service teachers’ metaphorical perceptions towards biology. *Mustafa Kemal University Journal of Social Sciences Institute*, 10(21), 208-223.
- Yıldırım, A. & Şimşek, H. (2013). *Sosyal bilimlerde nitel araştırma yöntemleri* (9. Baskı) Ankara: Pegem Akademi Yayıncılık.[Qualitative Research Methods in Social Sciences (9th edition). Ankara: Pegem Akademi Publishing]
- Yob, I. M. (2003). Thinking constructively with metaphors. *Studies in Philosophy and Education*, 22(2), 127-138.
- Yücel A. S., Koçak C. & Cula S. (2010) An analysis on proactive-reactive personality profiles in student-teacher relationship through the metaphorical thinking approach. *Eurasia Journal of Mathematics, Science & Technology Education*, 6(2), 131-139.