World Applied Sciences Journal 3 (1): 45-50, 2008
ISSN 1818-4952

Turkish Pupils Understanding of Physical Concept: Force and Movement

[1]Ahmet Hakan Hançer and [2]Nazmi Durkan

[1]Department of Primary Education, Faculty of Education,
Cumhuriyet University, Science Education Program, Sivas, Turkey
[2]Department of Science Education, Faculty of Education, Pamukkale University, Denizli, Turkey

Abstract: This research was carried out to find out the misconception about the subject of "force and movement" in 7th and 8th class elementary science curriculum. For this purpose, a "Force and Movement Concept Test" that consists of 20 multiple choice questions was administered to 7th and 8th grade students in two different elementary schools located in center of Ankara. Results showed that students have misconception about s of "Force and Movement" subject.

Key word: Turkish pupil · concept formation · misconception · science education

INTRODUCTION

One of the main purposes of science education is to bring up the students' scientific literacy level. Scientific literacy is defined as to know the nature of science, to understand how the knowledge has been obtained, to perceive that science knowledge depends on the known truths and changes by new dues obtained, to know the basic concepts of theories and hypothesis and to perceive the difference between academical proof and personal opinion [1, 2].

As the main purposes and specific nature of the science education is kept in view, it is clear that effective science education is only possible by learning on concept level, not by memorizing.

According to Millar [3]; it is almost impossible for the students to follow the general approach of science and technology, or to argue the results of academical events without an established concept in science education. There are two factors that impede the full understanding the concepts, which are the first concept that students had and misconception. Köse *et al*. [4] stated that concepts are defined as abstract thinking. To learn concepts meaningfully and permanently, it is necessary to explore students' present knowledge and to make a plan of instruction considering it. It is emphasized that many learning strategies are inefficient to identify misconceptions and rectify them.

Terry *et al*. [5] expressed that the misconceptions may occur in conception methods of students or organization of scientific knowledgements. In Piaget's view, misconceptions add on each other like a structure. Misconceptions start as a gap resulting from lack of knowledge. This gap fills incidentally with the quality education given by the teacher, the present knowledge of the students and the experiences that they face. The knowledge obtained in this way fills the gap successfully to some extend, but after a certain point it may come as misconception.

The most important property of concept mistakes is that they carry an information quality and students don't see them different from other information. Misconception is one of the developers thinking processes for learning provided that being corrected in the right time, as Krmiloff_Smith and Inhellder claimed [6].

Students are generally much conservative subjects of the concept mistakes that they had and they put up resistance to change [2, 7-9], which poses an obstacle for them to learn the right academicals concept. First of all it is necessary to attract attention to these concepts [10].

Students generally have superficial information about concept but not an exact conception. Misconception doesn't have much differences from any other explanatory information; it is arranged in the same way, takes part in general new information and therefore, it is difficult to eliminate them [11].

Generally misconceptions cause improving wrong experiences about scientific concepts for students. Misconceptions, raise difficulty in obtaining new

Corresponding Author: Dr. Ahmet Hakan Hançer, Department of Primary Education, Faculty of Education, Cumhuriyet University, Science Education Program, Sivas, Turkey

concepts and students b ehave unwilling in giving up the old wrong concepts which likely to new concepts [5, 12-14].

Driver and Easly [15] and Osborne and Wittrok [16] stress that the students' misconceptions must be determined, because the knowledge accumulation that students have is important to give meaning to affections new information.

Aim of the study: This research was carried out to define how 7th and 8th year elementary school students\ perceive the concept of force and movement subjects and misconceptions about this subject.

MATERIALS AND METHODS

Sample: This research was performed during the first semester of 2004-2005 academic years, in two elementary schools located in the center of Ankara, capital city of Turkey. 287 students attending in 7th and 8th classes of schools constituted the sample of the research (The test performed 7th classes studied the subject of Force and Movement).

Data collection: A Force and Movement Concept Test (FMCT), which consists of 20 multiple choice questions, was developed by the researchers to explore the student's misconceptions on the subject of force and movement. The test was prepared as a model that extracted from the literature about the subject and teachers' opinion and then developed according to experts' opinions. The reliability of the test was calculated with KR-20 formulations.

The analyses of data: The students' responses to the multiple choice questions in Force and Movement Concept Test (FMCT) were obtained and evaluated according to class levels and answer styles and then the frequency percentages were found. According the findings, concept mistakes and the way how they constructed the concepts were evaluated.

Findings: In this part, example questions of the force and movement concept test used to define the misconceptions were discussed from.

Table 1: Research sampling

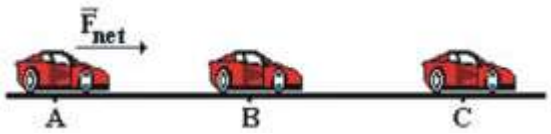
Grade	Female	Male	Total
7	73	75	148
8	77	62	139
Total			287

Table 1: The classification of the answers given by 7th and 8th year elementary school students to the 1st question

Question 1									
	Choice								
	A		B		C		D*		
Class	f	%	f	%	f	%	f	%	Total student
7	116	78.37	8	5.40	13	8.78	11	7.43	148
8	108	77.69	3	2.02	15	10.79	13	9.35	139
Total	224	78.04	11	3.83	28	9.75	24	8.36	287

"*": Right answer choice

Question 1: An F_{net} force was performed at a stationary car an a smooth way at the arrow direction to move the car in A position. The F_{net} force was removed after a short while the car moved. After the F_{net} force was removed which explanation below is right for speed of car in B and C positions? (The friction is neglected).



	B	C
A)	Slowing down	motionless
B)	Speeding up	Speeding up
C)	Speeding up	Slowing down
D)	Does not change	Does not change

With this question, it is expected for students to notify that when the force which speeding up an object removed, the object is going to continue its movement with a constant speed without stopping (if the fraction is absent), therefore and to give the answer that the speeds of car in B and C positions are not going to change.

As seen in Table 1, the ratio of students who give the right the answer is %8.36. The rest of the students (%9.75) selected wrong answers. When the wrong answers are examined, it can be said that %78.04 of the students have misconceptions. l high like "If the force does not continuously affect on an object, the object's movement slows down and it stops after a while". The situtation seems similar to the study of Halloun and Hestenes [17]. There is no apparent difference between the ratios of right and wrong answers of 7th and 8th class students.

Table 2: The classification of the answers given by 7th and 8th class elementary school students to the 2nd question

Question 2									
	Choice								
	A		B*		C		D		
Class	f	%	f	%	f	%	f	%	Total choice
7	93	62.83	37	25.00	13	8.78	5	3.37	148
8	86	61.87	41	29.50	10	6.75	2	1.35	139
Total	179	62.37	78	27.17	23	8.01	7	2.44	287

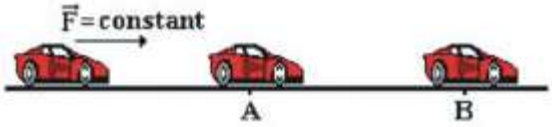
"*": Right answer choice

Table 3: The classification of the answers given by 7th and 8th elementary school students to the 3rd question

Question 3									
	Choice								
	A		B		C*		D		
Class	f	%	f	%	f	%	f	%	TotalQuestion
7	44	29,72	5	3,38	65	43,91	34	22,97	148
8	39	28,05	2	1,43	68	49,64	30	21,58	139
Total	83	28,91	7	2,44	133	46,34	64	22,29	287

"*": Right answer choice

Question 2: As shown in the figure a car, that is moving with the affect of a constant force, passed from the A point with a speed of 25 km per hour. What is its speed at the B point (Friction is neglected)?



A) 25 km/h
B) More than 25 km/h
C) Less than 25 km/h
D) The car stops at B point

With this question, it is expected for the students to notify that there is going to be an increase at the speed of a car, which is moving, with the effect of a constant force and, therefore, the speed of the car at the B point must be over 25 km per hour.

As it is seen in Table 2, the ratio of students who gave the right answer is % 27, 17. The rest of the students gave wrong answers.

When the wrong answers are examined, it can be concluded that a high ratio of students have misconceptions like "Objects move with a constant speed under effect of a constant force"

The situation seems similar to the studies of Watts and Zylbersztajn [18]; Gilbert and Watts [19].

In this question, it is seen that there is not a significant difference between right and wrong answer ratios of 7th and 8th class students.

Question 3: As shown in the figure, If the balanced forces effect on a car moving with a v speed, what can be said about its movement?

A) It slows down
B) It speeds up
C) The speed does not change
D) It stops

With this question, it is expected for the students to notify that if the forces that affect to an object are balanced, there is going to be no change at the object's situation; that is if the object is stopping, it keeps stopping, otherwise, if the object is moving it keeps moving. Therefore, it is expected that they give the answer that the speed of the car is not going to change.

As it seen in Table 3, the ratio of students who gave the right answer is % 46, 34. The rest of the students gave wrong answers. When the wrong answers are examined, it can be concluded that % 51, 02 of students have misconceptions like " If a moving object is affected by balanced forces, it slows down and stops"

In this question it is clear that there is not a significant difference between right and wrong answer rations of 7th and 8th class students.

Question 4: As shown in the figure, which expression below is right for the force that effects a stopping car?

A) The friction force affects
B) No force affects because the car is stopping.
C) The forces that affect the car are balanced
D) The gravity force does not effect the car

Table 4: The classification of the answers which were 7th and 8th elementary school students gave to the 4th question

Question 4									
	Choice								
	A		B		C*		D		
Class	f	%	f	%	f	%	f	%	Total choice
7	65	43.92	53	35.81	28	18.91	2	1.35	148
8	58	41.72	52	37.41	29	20.86	0	0	139
Total	123	42.86	105	36.58	57	19.86	2	0.69	287

"*": Right answer choice

Table 5: The classification of the answers given by 7th and 8th elementary school students to the 5th question

Question 5									
	Choice								
	A*		B		C		D		
Class	f	%	f	%	f	%	f	%	Total student
7	20	13.85	8	5.40	117	79.05	3	2.02	148
8	25	17.98	3	2.16	110	79.13	1	0.72	139
Total	45	15.67	11	3.83	227	79.09	4	1.40	287

"*": Right answer choice

With this question, it is expected for the students to notify that if an object is stopping the effecting forces are balanced, also to give the answer that the forces which effect the mentioned object are balanced.

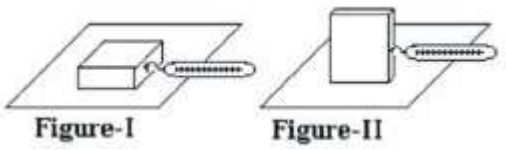
As seen in Table 4, the ratio of students who gave the right answer is %19.86. The rest of the students gave wrong answers.

When the wrong answer are examined, it can be said that 42.86% of students have misconceptions like "the friction force effects the stopping objects" and % 36.58 have concept mistakes like "If an object is not moving, there is no force effecting on it"

The situation seems similar to the studies of Gilbert and Watts [19]; Osborne and Wittrock [20].

In this question, it is seen that there is not a significant difference between right and wrong answer ratios of 7th and 8th class students.

Question 5: The friction force that effects the object in Fig. 1 is 8 Newton. If the same object is leaned on the other surface as shown in Fig. II, what can be said about the amount of friction force?



A) 8 N.
B) More than 8 N (Since surface area that contacts is increased)
C) less than 8 N (Since surface area that contacts decreased)
D) More data is required.

With this question, students were expected to notify that friction is due to the force that the object apply and properties of surface, but not areop of the surface, therefore, to give the answer that the force is 8 N.

As seen in Table 5 ratio of the students that gave the correct answer is 15.67 %. On the other hand, 3.83 % of the students supposed that since the surface area that contacted on table increased, friction force was more than 8 N, 79.09 % of them supposed that since the surface area that contacted on table decreased, friction force was less than 8 N and 1.40% supposed that data given was insufficient.

As the result was examined it is clear that 79.09 % of the students have misconception such as friction force is dependent on surface area and as the surface area of a substance increases, the friction force decreases.

In this question it is seen that there is not a significant difference between right and wrong answer ratios of 7th and 8th class students.

RESULTS AND CONCLUSION

In this study, which was carried out for purpose of defining misconception that 7th and 8th class elementary school students have about force and movement subject, it was revealed that misconception are:

- Objects move with a constant speed under a constant force,
- When force does not affect an object continuously, the movement of the object slows down and stops after a while,
- The friction force affects the stopping objects,
- If a moving object is affected by balanced forces, it slows down and stops,
- If an object is not moving, there is no force effecting it,

- The friction force depends on the surface area of the object.

It also surprising that rate of misconceptions was not significantly different between 7th and 8th class elementary school students.

Although 8th class students studies force and movement subjects in previous year, they have the same misconceptions and same ratio as the 7th class students who studied this subject in 5th year of education.

The reasons for this significant finding are:

- Students have learned this subject via traditional learning method, which is not enough to learn concept,
- They probably memorized the concept without learning in depth,
- Their preconceptions were not researched before starting the lesson.

If the students agree on the scientific knowledgement, they adopt it and this becomes their selves.It was established that, because the scientific knowledge was transferred to the students as a certain truth and it was not allowed to be examined in the science education so far, they do not adopt the scientific knowledge but conserve it. It was reported that especially the students who were educated science according to traditional methods in past 20-25 years, have many misconception. For example; starting from elementary school level, students were reported to have misconception about heredity Baret and Ayuso [21], about light Guense *et al*. [22], about granular structure of the matter Haidar and Abraham [23], Lee *et al*. [24], Ayas [25].

The purpose of science education is to obtain the meaningful learning. The integration of present knowledge with the newly obtained knowledge in science lessons by students shows the success of science education.

Therefore, the newly learned knowledge must be adapted with the opinions, which was formed before in minds. Otherwise, disagreements in the mind are going to be an obstacle for meaningful learning. Therefore, misconception that students have must be defined in the beginning of lesson and they have must certainly be corrected. Teachers must be aware of common misconceptions in science education and must take necessary measures to remove them. Besides this, they must keep in mind their own abilities, knowledge, interests and they must consider sources that can be used in their near surroundings.

In addition, instead of simple method such as telling and explaining, teachers must adopt some new education methods such as student centered experimental education which keeps students active, computer simulations, using analogy suitable for student properties, class level, physical conditions of class and level of the students in the class and they must use these new education methods and techniques effectively [2, 26].

Textbook, which is an important part of education, must be prepared suitable for mental improvement level of students, preventing the development of misconceptions and paradoxes in their minds.

REFERENCES

1. Hançer, A.H., 2005. An Investigation of the effects of computer aided instruction in a constructivist learning environment on learning outcomes in science education. Ph.D Thesis, Institute of Education Sciences. Gazi University, Ankara, Turkey.
2. Uşak, M., 2005. Prospective elementary science teachers' pedagogical content knowledge about flowering plants, Ph.D Thesis, Institute of Education Sciences. Gazi University, Ankara, Turkey.
3. Millar, R., 1989. Constructive criticisms. Intl. J. Sci. Edu., 1: 587-596.
4. Köse, S., K. Gezer, N. Durkan and G. Erol, 2006. The effectiveness of drawing in the identification of misconceptions. 14th National Educational Science Congresses, Pamukkale University, Denizli, Turkey
5. Terry, C., G. Jones and W. Hurford, 1985. Children's conceptual understanding of forces and equilibrium. Phy. Edu., 20: 162-165.
6. Rowell, A.J., C.J. Dawson and L. Harry, 1990. Changing misconceptions: A challenge to science education. Intl. J. Sci. Edu., 12 (2): 167-175.
7. Benson, D.L., M.C. Wittrock and M.E. Baur, 1993. Student's preconceptions of the nature of gases. J. Res. Sci. Teaching, 30 (6): 587-597.
8. Fellows, N.J., 1994. A window into thinking: Using student writing to understand conceptual change in science learning. J. Res. Sci. Teaching, 31 (9): 85-1001.
9. Schmidt, H.J., 1997. Students' misconceptions' looking for a pattern. Sci. Edu., 81: 123-135.

10. Eisen, Y. and R. Stavy, 1992. Material cycles in nature: A new approaches it teaching photosynthesis in junior high school. The Am. Biol. Teacher, 54 (6): 339-332.
11. Stephans, J., 1996. Targeting students' science misconceptions: Physical science concepts using the conceptual change model. Riverview, Fla.: Idea Factory.
12. Hewson, P. and M. Hewson, 1991. The Status of students conceptions research in physics learning: Theoretical issues and empirical studies. Institute for Science Education at the University of Kiel, pp: 59-73.
13. Aydin, H. and M. Uşak, 2003. The importance of the investigation of alternative conceptions in science classes: A theoretical approach. Pamukkale University, Eğitim Fakültesi Dergisi, 13 (2): 121-135
14. Taşar, M.F., 2006. Probing preservice teachers' understandings of scientific knowledge by using a vignette in conjunction with a paper and pencil test. Eur. J. Math. Sci. Technol. Ed., 2 (1): 53-70.
15. Driver, R. and J. Easly, 1978. Pupils and paradigms: A review of literature related to concept development in adolescent science students. Studies in Science Education, 5: 61-84.
16. Osborne, R.J. and M.C. Wittrock, 1983. Learning science: A generative process. Science Education, 67 (4): 489-508.
17. Halloun, I.A. and D. Hestenes, 1988. Common sense concepts about motion. Am. J. Phy., 53 (11): 1056-1065.
18. Watts, D.M. and A. Zylbersztajn, 1981. A survey of children's ideas about force. Physics Education, 16: 360-365.
19. Gilbert, J.K. and D.M. Watts, 1983. Concepts, misconceptions and alternative conceptions: Changing perspectives in science education. Studies in Science Education, 10: 61-98.
20. Osborne, R.J. and M.C. Wittrock, 1983. Learning science: A generative process. Science Education, 67 (4): 489-508.
21. Baret, E. and E. Ayuso, 2000. Teaching genetics at secondary school: A strategy for teaching about the location of inheriance information. Science Education, 84: 313-351.
22. Guesne, E., 1985. Light. In R. Driver, E. Guesne and A. Tiberghien (Eds.), Children's ideas in science, Open University Pres, Milton Keynes, UK, pp: 10-32.
23. Haidar, A.H. and M.R.A. Abraham, 1991. Comparison of applied and theoretical knowledge of concepts based on the particulate nature of matter. J. Res. Sci. Teaching, 28 (10): 919-938.
24. Lee, O., D.C. Eichinger, C.W. Anderson, G.D. Berkheimer and T.D. Blakeslee, 1993. Changing middle school students' conceptions of matter and molecules. J. Res. Sci. Teaching, 30 (3): 249-270.
25. Ayas, A., 1995. A Investigation of secondary scholl students understanding level about particulte ofsturucture matter. II. Ulusal Fen Bilimleri Eğitimi Sempozyumu, ODTÜ Faculty of Education, Ankara, Turkey.
26. Bilen, K., 2004. Perceptions of primary school science pre-service teachers' views about characteristics of effective teaching of science and effective science teacher. Unpublished Master Theses. Pamukkale University, Turkey.