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THE EFFECT OF FIRE CONTEXT ON THE CONCEPTUAL UNDERSTANDING OF STUDENTS: "THE HEAT-TEMPERATURE"

Arzu Kirman Bilgin[1],
Sibel Er Nas[2i],
Tülay Şenel Çoruhlu[2]
[1] Kafkas University, Faculty of Education, Kars, Turkey
[2]Karadeniz Technical University, Fatih Faculty of Education, Trabzon, Turkey

Abstract:
The purpose of this research is to investigate effects of the guiding materials developed based on the REACT teaching model relate to "heat-temperature" concepts in the conceptual understanding of students. The sample group of the study consists of 5th grade students selected from elementary school. A total of 56 (experiment group 27, control group 29) students from two classes have participated in the study. A quasi-experimental method has been used in this study. Experiment and control groups' obtained test scores are measured before and after the intervention and these results are compared with each other. A concept test, an interview consisting of semi-structured questions and a drawing test, have been utilised in the research. While no significant difference (U=373.5; p>.05) has been found between the pre-test scores of the control group and experiment group students, a significant difference (U= 271.5; p<.05) has been found in favour of the experiment group in the post test. The materials prepared in accordance with the "The fire context" which was applied in the experiment group had positive effect in students' conceptual understanding.

Keywords: conceptual understanding, fire context, heat, temperature

1. Introduction

The context-based teaching theory which has been formulated for students to find an answer to this question is taken as a basis in the curriculums of many countries in the

[i] Correspondence: email sibelernas@hotmail.com

last twenty years. Whereas in Turkey, science curriculum (Ministry of National Education, 2013) has been updated as of the 2013-2014 academic year in light of constructivism. Even though the relating of subjects with daily life has been emphasized, indications of context-based teaching are not encountered enough. Nevertheless, no teaching model has been adopted in the curriculum and the selection of the teaching model has been left to teacher. Therefore, teachers need teaching designs which are to be developed in the framework of the context-based theory. The organization called the Center of Occupational Research and Development (CORD) have investigated the reasons of lack of motivation and academic failure encountered in science and mathematics classes. As a result of their research, they have determined that teachings discuss the place and importance of concepts in our lives by using different strategies and succeeded in conceptual understanding. They have created the REACT teaching model by combining these strategies. REACT teaching model involves the steps of **R**elating in which the fact that the related subject and life are a whole is tried to be understood, **E**xperiencing in which students are tried to be felt like scientists, **A**pplying in which the subject's relationship with professional life is discussed, **C**ooperating in which the students' self-confidence is tried to be discovered and **T**ransferring in which a newly-encountered event is tried to explained with a learned subject (Crawford & Witte, 1999; Hull, 1999). The emphasis on contextual learning in each of its steps (Navarra, 2006) and the suggestion that teachings to be developed should be enriched with different contexts (CORD, 1999) distinguish REACT from other teaching models.

The concepts of heat and temperature are among the most widely-used concepts in our daily lives. We use these concepts frequently in many events such as weather forecast news, when we are ill, in determining the under which conditions we must store drugs, in cultivation and cooking. However, as students interpret the relationship of these evernts with heat and temperature, they use these concepts interchangeably (Lewis & Linn, 1994; Maskill & Pedrosa, 1997; Carlton, 2000; Jones, Carter & Rua, 2000; Niaz, 2000, 2006; Yeo & Zadnik, 2001; Mc Dermott, 2003; Baser & Geban, 2007; Paik, Cho & Go, 2007; Tanahounga, Chitareeb, Soankwanb, Sharmac & Johnstonc, 2009; Gürcay & Gulbas, 2015). Our use of concepts outside of their scientific meanings in our daily lives makes the learning of these concepts more difficult (Lubben, Netshisuaulu and Campell, 1999). Students are not able to structure science concepts in their minds. This leads to the inability of students to explain their contexts (Bennett, Hogarth & Lubben, 2003).

The concepts of heat and temperature are included in the 5th grade Matter and change unit of the science curriculum. Inability of learning these concepts makes the correct learning of some other concepts (such as change of state, dilatation-contraction, physical-chemical change, diffusion paths of heat, specific heat, dissolution, energy and

weather events) more difficult. Considering even university students (Kesidou & Duit, 1993; Kaptan & Korkmaz, 2001; Tanahoung, Chitaree & Soankwan, 2010, Alwan, 2011) confuse the features of the heat and temperature concepts, the structuring of these concepts in the minds of 5th grade students is important for science education. Conducted studies emphasize the fact that students have alternative concepts about heat and temperature. For instance, students think of heat as matter (Hapkiewichz, 1992; Harrison, Grayson & Treagust, 1999; Başer & Çataloğlu, 2005) and heat is not energy (Hapkiewichz, 1992). They state that cold objects have no temperature and temperature is an energy (Kesidou & Duit, 1993). Jasien and Oberem (2002) have determined that students find it difficult to learn the relationship between heat transfer and temperature change. In addition, other alternative concepts include the misconceptions that temperature is transferred while heat is not (Başar & Çataloğlu, 2005) and heat and temperature are the same concept (Alwan, 2011). The thought of students that these concepts are the same concept also lead them to think the tools which measure heat and temperature are the same as well (Başer & Çataloğlu, 2005; Gönen & Akgün, 2005). The frequent detection of these types of alternative concepts in students brings the importance of this study into the forefront. The study is believed to be contributing to the elimination of the detected alternative concepts.

Students' understanding of what to do with the concept they will learn in their daily lives is of utmost importance to provide their attention to class. This can only be achieved in the framework of a context (Morrison, Ross, Kemp & Kalman, 2010). Context can be defined as applying a context, discussing the results in the application and discovering the place and importance of the concept in a given event (Gilbert, 2006). Kasanda, Lubnen, Gaoseb, Kandjeo Marenga, Kapenda & Campbell (2005) have stated that contexts can be used to draw attention to class, assess and apply a skill. They particularly emphasize that assessment activities which include context is an important instrument in the reinforcement of the bond between scientific contexts and daily life experiments. The "fire" context has been taken as a basis in this study. Because, news about fire breakouts in forests or buildings are encountered almost every day in Turkey. By selecting this context which is a natural disaster, the attention of students to the subject has been ensured. The fire context which has been used in the designed teaching has been presented to students by utilizing a real case study (Figure 1). Because CORD (1999) emphasize context must be enriched with texts, videos, discussions and different in-class activities. By selecting the "fire alarms systems"context in the dilatation and contraction subject which follows the heat and temperature subject, coherence has been tried to be achieved between two subjects.

The related literature points to a need for studies on REACT teaching model at elementary level, since few studies have been carried out on the REACT teaching model at elementary level.

Even though the relating of subjects with daily life has been emphasized, indications of context-based teaching are not encountered enough. teachers need teaching designs which are to be developed in the framework of the context-based theory. Further studies should be undertaken to investigate the possible effect of the REACT teaching model on elementary students' conceptual understanding related to different concepts. The main contribution of this paper to the literature relates to how the REACT teaching model affects students' conceptual understanding related to the heat and temperature. Teachers should be used guiding materials developed based on the "fire context" related to "heat-temperature" concepts in learning environments.

2. Aim of the study

The purpose of this research is to investigate effects of the guiding materials developed based on the "fire context" related to "heat-temperature" concepts in the conceptual understanding of students. The following research question guided the present study: do guiding materials developed based on the "fire context" relating to "heat-temperature" concepts effect students' conceptual understanding?

3. Methodology

A quasi-experimental design has been used in this research. The groups were established through a non-random selection during the formation of sample (Tharenou, Donohue & Cooper, 2007). Groups were composed as experiment and control groups through equitable assignment using a quasi-experimental method (Büyüköztürk, 2004). The experiment and control groups' obtained test scores are have been measured before and after the intervention and the results are compared with each other below.

3.1 Sample

The sample group for the research consists of 5th grade students selected from secondary school. A total of 56 students from two classes [One control group (with 29 students—16 girls and 13 boys, mean age: 11.68) and one experimental group (with 27 students—14 girls and 13 boys, mean age: 12.08)] have participated in the research. Two voluntary teachers from the same school have participated in the research. The teachers have both graduated as science teachers from university. The experimental group teacher had six years experience and the control group teacher had seven years of experience. Both teachers were provided with information by the researchers with the aid of materials, before the intervention.

3.2 Data collection

A concept test, an interview consisting of semi-structured questions and a drawing test have been used in this research. Concept test including two open-ended questions. These questions are; "*How would you describe heat? What are the characteristics of the heat? Please explain.*" And "*How would you describe temperature? What are the characteristics of the temperature? Please explain."*

The interviews were conducted to investigate the effectiveness of the materials on the conceptual understanding of students. Interview questions which are the same with the concept test questions were used in the research. Individual interviews were used in this study and interviews were conducted by the researchers. Preliminary and final interviews were conducted with 10 of the experiment group students (E3, E7, E11, E13, E16, E17, E20, E21, E25 and E27).

Drawing is a technique which ensure the discovery of dimensions which cannot be discovered with open-ended and other understanding research techniques (White & Gunstone, 1992). Drawings are very valuable as they provide more detailed information beyond words. Students were asked to make drawings with the aim of investigating the effect of developed materails on conceptual understanding. The questions the students were asked are as follows: "*What do you understand by the concept of heat? Please show by drawing*." and "*What do you understand by the concept of temperature? Please show by drawing*."

3.3 Validity and reliability

Concept and drawing test were administered one week before the intervention as a pre test to experiment and control groups. The same tests were employed as a post test immediately after the intervention to these groups. To enhance content and face validity the tests were evaluated by two science educators and two science teachers. To measure the reliability of the concept and drawing tests, they were implemented on 15 6th grade students, who learned these concepts at 5 th grade. Semi-structured interview questions were administered one week before the intervention as a pre interview for 10 of the experiment group students. The same questions were employed as a post interview immediately after the intervention. To measure reliability of the semi-structured questions, it was implemented 3 grade 6 students. Interviews were recorded. Each interviews took approximately 10-12 minutes.

3.4 Data analysis

Marek's (1986) categorisation has been used in the analysis of the concept test and interviews. The following criteria; Complete Understanding (Code A) (3 points), Partial Understanding (Code B) (2 points), Alternative Concept (Code C) (1 point), No

response or Irrelevant Responses (Code D) (0 point) has been was utilised. Mann–Whitney U-test has been used to compare the experiment and control groups' scores.

The data obtained from the drawing test has been presented with tables including frequency values. Students drawings were examined in detail. Codes were composed according to students drawings. For example; student drawings related to the concept of heat examined wih these codes; "heater", "sun", "calorimeter", "thermometer", "friction", "melting", "heat transmission", "boiling" and "no drawing". Also samples from student drawings related to each codes have been showed in to the tables. Students were coded in line with research ethic. For instance, student number 1 from the experiment group has been coded correspondingly, as $E1_{PT}$ in the pre test and as $E1_{LT}$ in the post test. Student number 1 from the control group has been coded similarly as $C1_{PT}$ and $C1_{LT}$.

3.5 Teaching design

In this research materials were prepared according to the REACT (**R**elating / **E**xperiencing, **A**pplying, **C**ooperating, **T**ransferring) teaching model was taking into consideration in the experiment group. The 5E (**E**ntering/**E**ngagement, **E**xamining, **E**xplaining, **E**laborating and **E**valuating) teaching model from the constructivist approach was used in the control group and the teacher used the coursebook (Bayram and Kibar, 2014) in the process. The observation notes obtained from the teaching process by one of the researchers a nonparticipant who observed are summed below. The intervention process consisted of five classes of 40 minutes in two groups. The intervention process in the experiment and control group has been presented in Table 1.

Table 1: Teaching design in the control and experiment groups

L.	Experiment Group (Designed by researchers)	Control Group (Based on the curriculum materials)
1st lesson	Relating: It was attempted to engage the attention of students on the subject by asking them the relationship between fire and heat-temperature on the basis of the fire context (Appendix 1).	Entering: Students were asked "What do you do when you are cold?" and to examine the photographs in the book. After stimulating the prior knowledge of students, the key concepts of heat, thermometer and heat exchange related to the subject were given.
2nd lesson	Experiencing: Students were made to conduct the "The mystery of water" experiment (Appendix 2). Students work with goups. The experiment was presented in a worksheet format. The drawing attention and active occupation sections of the worksheet were used.	Exploring: The "What has happened to cottons" activity was carried out. The purpose of the activity is to demonstrate the increase in heat with the motion of cottons
3rd lesson	Applying: Assessment section of the worksheet was used.	Explaining: The teacher who listened to the answers of students explained the characteristics of the heat and temperature concepts to students.

4th lesson	Cooperating: The drama activity (Appendix 3) was used in the cooperating step to facilitate the students' sharing of what they had learnt and ensure their cooperative work.	Elaborating: Two glasses of water with different temperatures were brought in the actvitiy. Students were asked to measure the first temperatures of the waters in glasses. After mixing the waters, students measured the temperature again and compared the first temperature and last temperature.
5th lesson	Transfering: After the cooperating step is completed, the Transferring step was passed on to. Two case studies (Appendix 4) related to everyday life were used.	Evaluating: The teacher summarised the subject and asked students to carry out the self-assessment activity.

4. Results

The Mann Whitney U-Test results from the concept test pre-post test scores according to the experiment and control groups have been presented in Table 2.

Table 2: Results of the Mann Whitney U-test

Test	Groups	n	Mean Rank	Sum of Rank	U	p
Pre test	Experiment	27	29,17	787,50	373,5	0,73
	Control	29	27,88	808,50		
Post test	Experiment	27	32,94	889,50	271,5	0,04
	Control	29	24,36	706,50		

Analysis results indicate that there is no significant difference between the pre-test scores of the concept test implemented on the experiment and control group (U=373,5; p>.05). Analysis results indicate that there is a significant difference in favour of the experiment group between the post test scores implemented on experiment and control groups (U= 271,5; p<.05). Frequency distribution of the answers given to the concept test has been presented in Figures 1 and 2.

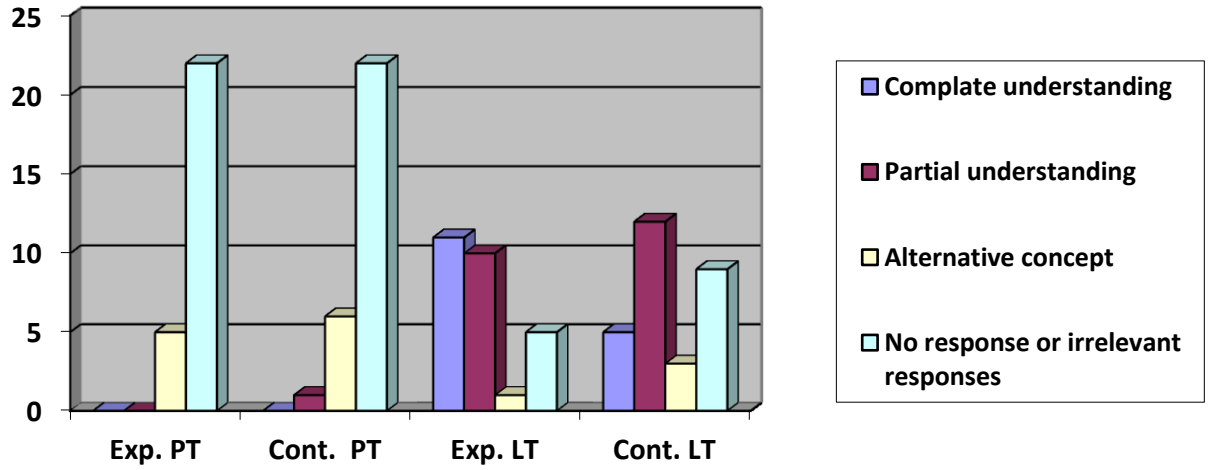


Figure 1: Students' frequency distribution in each categories related to heat concept (Exp. PT: Experiment group pre-test; Cont. PT: Control group pre-test; Exp. LT: Experiment group post-test; Cont. LT: Control group post-test)

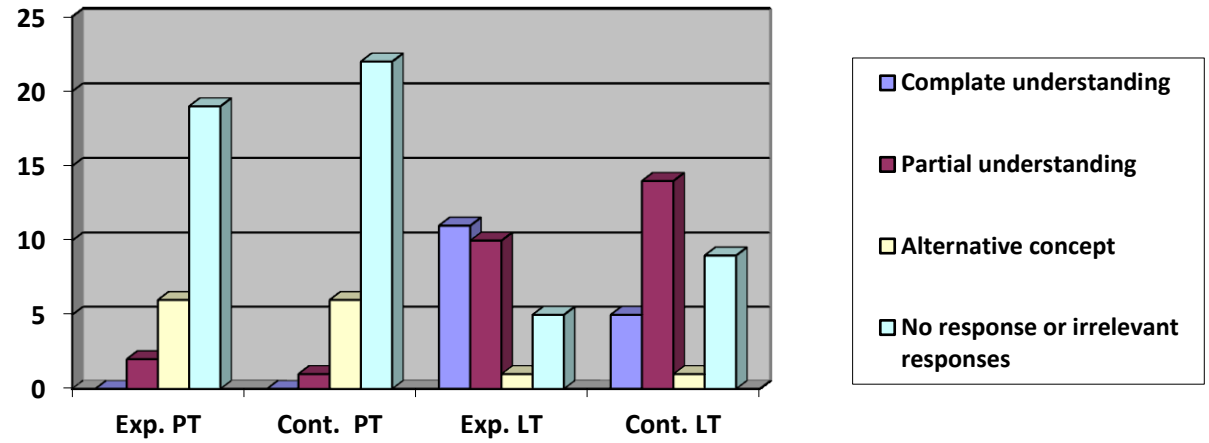


Figure 2. Students' frequency distribution in each categories related to temperature concept.

Table 3 shows example statements from each categories relate to expansion and contraction concepts

Table 3: Example statements from each category

A	Heat	Heat is a type of energy. It is measured with a calorimeter container. It depends on the matter amount. Its unit is calorie and joule. (C5, 6, 21, 24, 29_{LT}- E4, 20_{LT})
	Temp.	Temperature is a measurement. It is measured with thermometer. It does not depend on the matter amount. Its unit is degree. (C5, 21_{LT}-E4,17_{LT})
B	Heat	Heat is an energy. ($C13_{PT,}$ $E8_{LT}$)
	Temp.	The unit of temperature is degree. (E15, 25_{PT})
C	Heat	Heat is the temperature of an object. ($E2_{PT}$ -C20, 22_{PT})
		The weather having 20 ^{0}C heat. ($E4_{PT}$-$C11_{PT}$)
		Thermometer measures heat. ($C19_{PT}$)
		Heat is the warmness the sun reflects on our faces. ($C1_{LT}$)
		Temperature is measured while heat is not. (C19, 22_{LT})
		Heat is materials colder than temperature. ($C17_{PT}$-$E26_{LT}$)
		Heat is matter. ($C24_{PT}$- E13, 24_{PT} -$E6_{LT}$)
	Temp.	Temperature is the heat of an object. (C13, 20, 22_{PT}- $E5_{PT}$)
		Temperature has mass and volume. ($E6_{LT}$)
		Temperature is more than heat. (E7, 8, 18_{PT}-$C17_{PT}$)
		There is no difference between heat and temperature. (E23, 24_{PT})
		Heat is measured with temperature. ($C27_{LT}$)
		The warmth the sun (stove or radiator) radiates. (C6, 11_{PT})
D	Heat	Heat comes from radiator, stove. ($C13_{PT}$)
	Temp.	Temperature prevents us being cold. ($E4_{PT}$)

Note: PT: Pre Test D: Experiment Group Students A: Complete Understanding C: Alternative Concept LT: Post Test, C: Control Group Students, B: Partial Understanding, D: No or Irrelevant Answer

When Table 3 is examined, it is observed that students from both groups do not have any answers in the A category for the pre-test. It is observed that students from both groups do not have any answers in the A category for the pre-test. The findings obtained from the student drawing test have been below. Frequencies of the data

obtained from question 1 and 2 which are related to the heat and temperature concepts have been presented in Table 4.

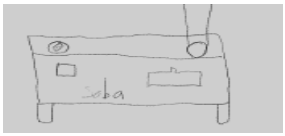
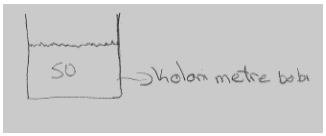
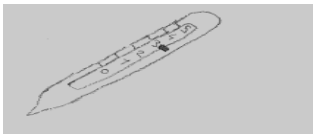
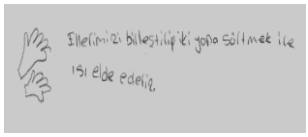
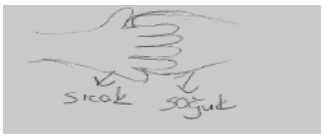
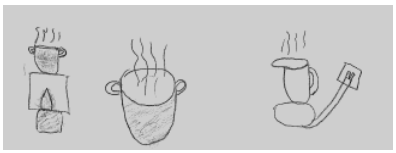
Table 4: Frequencies and categories of the findings obtained from the drawing test

Concepts / Categories	Heat				Temperature			
	Experiment Group		Control Group		Experiment Group		Control Group	
	PT (f)	LT (f)	PT (f)	LT (f)	PT (f)	LT (f)	PT (f)	LT (f)
Heater (stove or radiator)	9	3	7	11	6	2	7	4
Sun	4	10	6	3	6	1	5	7
Boiling	8	3	8	4	-	-	-	-
Thermometer	3	-	5	5	3	13	5	6
Friction	-	-	1	-	-	-	-	-
Heat transmission	-	3	-	2	-	-	-	-
The calorimeter	-	4	-	2	-	-	-	-
Melting	2	2	-	-	-	1	1	1
Sweating	-	-	-	-	11	3	10	10
No drawing	1	2	2	2	1	7	1	1

Note: PT: Pre test, LT: Post test

When the pre and post drawings of the students on the concept of heat are examined, it is observed that most of them made drawings which include the categories s of heater, sun and boiling. When five of the pre and post drawings of control group students are examined, it is observed that they tried to explain the concept of heat by drawing a thermometer. When the pre-drawings of students on the concept of temperature are examined, it is observed that most of them relate the concept of temperature with sweating. When the post drawings of students are examined, however, it is observed that the drawing with the highest frequency is thermometer. Moreover, some students are observed to have tried to demonstrate that temperature stems from the sun in the pre-test. Samples of the student drawings related to the concept of heat have been presented in table 5.

Table 5: Samples of the student drawings relate to heat-temperature concept

The sample of heater	The sample of sun	The sample of the calorimeter
		
E14PT	E3LT	C22LT
The sample of thermometer	**The sample of friction**	**The sample of melting**
		
C21LT	C24PT	E7LT
The sample of heat transmission	**The sample of boiling**	
		
E20LT	E23LT	C14PT

The findings obtained from the interview questions related to the concept of heat and temperature have been presented in Table 6 below.

Table 6. Categorization of the answers given to the first interview question and sample statements

		Sample Statements
A	Heat	Heat is a type of energy. Heat depends on the number of particles. It is measured with a calorimeter container. Heat transfer occurs. It depends on the matter amount. Its unit is calorie and joule. (E3,7,11,16,17,20, 21, 25, 27_{LI}).
	Temp.	Temperature is a measurement. It is measured with thermometer. Its unit is degree. Heat and temperature are different things. However, there is relationship between them (E3,7,21,25,2_{LI}). Temperature is the value we measure. It is measured with thermometer. Its unit is degree. Heat and temperature are different (E11_{LI}).
B	Heat	Heat is the total of the energies of particles. Heat flow is from hot to cold. For instance, a rich person cannot lend to a rich person. However, a rich person can lend to a poor person (E13_{LI}).
	Temp.	Temperature is measured with thermometer. Temperature is not energy (E13, 16_{LI}). Temperature is the indicator of warmth and cold. Temperature is measured with thermometer (E17, 20_{LI}).
C	Heat	We can state that heat and temperature are the same thing. They are similar to one another. Heat can exist in any environment. Heat exists everywhere. Temperature exists only in certain places (E11_{PI}). Heat is the increase in the temperature of a thing. It is the warmth stemming from the sun (E13_{PI}). Heat is matter (E21_{PI}). Heat is a gas. It is a gas like air (E27_{PI}).

	Temp.	It is matter at a higher degree than heat. It is hotter than heat ($E21_{PI}$). Temperature is something that may change according to heat. When water is put on a stove, its heat starts to boil at a certain point. Temperature occurs at a certain limit. It manifests itself when it reaches a certain point. The boiled water boils at a certain temperature. Hence, temperature occurs ($E11_{PI}$). Temperature is the heat emitted from something ($E3,13_{PI}$). It is matter. It is matter depending on heat. In the same vein, when we heat up, temperature occurs ($E17_{PI}$). Temperature is the ray the Sun gives us. The degree of temperature is high. Heat is not like that ($E20_{PI}$).
D	Heat	The sun comes to mind with heat. Heat is the heat output of matter ($E3,7,16,17,20_{PI}$). Heat is a thing which exists at a certain temperature, boils and evaporates. Heat can melt something. It can evaporate. Heat is incendiary ($E25_{PI}$).
	Temp.	Temperature is remaing warm with the help of something hot ($E7,16,27_{PI}$). It is a thing at a certain degree and becomes incendiary when this degree is exceeded ($E25_{PI}$).

Note: PI: Pre-Interview, LI: Post-Interview

When the answers student gave to the interview question are examined, it is observed that students do not have any answers in the complete and partial understanding categories in the pre-interviews. In the post-interview, 9 of the students gave answers in the complete understanding category. No alternative coccept has been encountered in the post-interview. When the answers obtained from the second question (related to temperature) are examined, it is observed that there are no questions in the complete and partial categories in pre-interviews. Whereas in the post-interview, all of the students gave answers in these categories.

5. Dıscussıon

Involving the events which occur in the lives of students in the teaching process can be stated to be important in the learning of scientific concepts. Both concept test and drawing test data demonstrate that experiment group students are more successful than control group students. This may arise from the selected fire context. The context-based teaching theory is a solution in terms of students' relating of science and life in science teaching (Whitelegg & Parry, 1999). This is seen clearly with the conducted interviews as well. It can be said that the context-based teaching theory facilitates an effective conceptual change process (Gilbert et al., 2011) and the materials prepared for the REACT teaching model comprises a productive teaching process (Crafword & Witte, 1999). Ramsden (1997) has established in his study that lessons conducted with a context-based teaching have positive effects on the conceptual understanding of students. Barker and Millar (1999) have concluded in their study that context-based teaching contributes to the correction of students' misconceptions significantly. Wu (2003) has asserted that context-based teaching affects students' relating of chemistry concepts with real life experiments positively. In a similar vein, studies on the

effectiveness of teachings which were developed on the basis of context-based theory on the conceptual understanding of students exist (Barker & Millar 2000; Belt, Leisvik, Hyde & Overton 2005; King 2009; King, Winner & Ginns 2011).

When the pre-drawings of students are examined (Table 4 and 5), it is observed that they have related the concept of heat with thermometer. The fact that students tried to explain the concept of heat by drawing thermometer can be considered as an indicator of how important daily life experiences are in the teaching of concepts. Students are known to be subjected to unscientific concepts in the daily life language. This situation may cause students' misuse of the heat-temperature concepts interchangeably. For instance, body heat instead of body temperature is a misuse which is quite common in daily life. Students may have identified the thermometer which is used to measure body temperature with the concept of heat due to this misuse. When post-drawings are examined, however, it is observed that experiment group students digressed from this conception. Whereas in the control group, 5 students are observed to have drawn thermometers when the concept of heat came up (Table 4). Therefore, this may be considered as an indicator that students have the conception of heat being measured with thermometer. The fact that the instruments measuring heat-temperature are used interchangeably is an alternative conception which has been identified in the related literature as well (Başer & Çataloğlu, 2005; Gönen & Akgün, 2005). Likewise, some students are observed to have drawn the sun to explain the concept of temperature. When the pre-drawing made by the student with code E24 PT is examined, the student defined temperature as the "warmth emitted by the sun" alongside his/her sun drawing. Statements like "I'm feeling quite hot" which is used in daily life on sunny days may have led students to think the sun as a source of temperature. This conception, hence, causes them to identify temperature as an energy. This may be considered as an indicator of how important daily life experiences are in the teaching of concepts. Explanations which involve unscientific statements used among the public are known to be effective in the formation of alternative concepts in students (Ünal & Coştu, 2005). When student drawings are examined, it is observed that they took the heat factor into consideration in the change of state events such as boiling and melting. This situation may have been indirectly contributed by the activities of "The Mystery of Water" used in the experiment group and "What Has Happened to Cottons?" used in the control group. In addition, their learning of change of state phenomena in the 4th grade may have caused the relating of heat with these phenomena (Table 6).

When the answers students gave to the 1st question which was asked related to the concept of heat in the concept test are examined, it has been concluded that some students think heat as matter. In the pre-interviews conducted with students code E21 and E27, this situation is observed in detail. Thus, in the studies carried out by Ericson (1979; 1980), the misconception of "Heat is matter like air and vapour" has been

detected. Kesidou and Duit (1993) have detected the misconception of "Heat is high temperature" among students in their study. In this study, students have been detected to have the misconception of "heat is low temperature" contrary to the study of Kesidou and Duit (1993).

The fact that students think there is no difference between heat and temperature has been established via the applied concept test (Table 3). This conclusion shows parallelism with many conducted studies (Lewis & Linn, 1994; Carlton, 2000; Yeo & Zadnik, 2001; Jasien & Oberem, 2002; Aydoğan, Güneş & Gülçiçek, 2003; McDermott, 2003; Uzoğlu & Gürbüz, 2013). With a higher number in the control group, the majority of students in the experiment group explained the concept of temperature with drawing showing a sweating individual also. However, it is also understood from these drawings that students disregarded the existence of heat transfer with the occurrence of temperature difference. The fact that the age group of students was low may have affected their non-statement of some factors in their drawings. The sweating category which has emerged in this study is another example of how effective events we encounter in our daily lives on the learning of scientific concepts.

6. Conclusıons

Whereas no signficant difference has been found between the pre-test points obtained from the concept test of control and experiment group students ($U=373,5$; $p>.05$), a significant difference has been found in the post-test in favour of the experiment group ($U= 271,5$; $p<.05$). The teaching carried out in the experiment group has affected the conceptual understanding of students positively. This may have arised from the materials prepared in accordance with the REACT teaching model which was applied in the experiment group. The fire context which broke out in a school in Sivas has been taken as a basis in the Relating step of the REACT teaching model used in the study. King, Winner and Ginns (2011) define context as the "scientific application of real life situations". The students' attention to the subject at hand was ensured by particularly using a case study text related to a fire breakout in a school. Case studies which are prepared by establishing contexts including cases from the daily life are stated to be effective in the teaching of contexts by various studies (Belt, Leisvik, Hyde & Overton, 2005; King, Bellocchi & Ritchie, 2008).

7. Suggestıons

When research results are examined, it is observed that students mostly related the concept of heat with heater, the sun, change of state categories while they mostly related the concept of temperature with heater, the sun and sweating categories. For

future studies, a debate activity discussing the relationship of these emerging categories with the concepts of heat and temperature can be conducted in the cooperating step of the REACT teaching model.

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Appendıx

Appendix 1: Material used in the Relating step

HEAT AND TEMPERATURE

The photograph you see on the side shows a fire which brokeout in the Sivas province of Turkey. While the roof of the school burned completely, intervention of firemen prevented damage to classrooms. Although loss of property was big, occurence of fire at the weekend prevented loss of life.We can understand what a threat fires pose on the basis of this event.

What do you feel when you approach a burning object?

What are the characteristics of what you feel?

Appendix 2: Material used in the Experiencing and Applying steps

THE MYSTERY OF WATER

We add ice to our water to cool off in hot summer days.
How does this cooling-off occur?

Let's conduct the activity below and seek an answer to this question.

Activity 1: Water and ice

Tools-materials: 1 electric heater, 2 beakers of 250 ml and 400 ml water, 2 pieces of ice in the size of a nut, 2 thermometers

- Pour 200 ml water you took from tap into beaker.
- Pour 200 ml water into the other beaker as well and wait until it boils on the heater.
- When the water boils, lower the beaker and put the beaker with non-boiled water in it.
- Submerge thermometers into the waters in two beakers and m their temperatures.
- Record the values you obtain into the table below.
- Add ice pieces of same size into the waters in the two beakers at the same time.
- At the 5th and 10th minutes, measure the temperatures of the waters again and record them in the table below.

Our Observations: Write down the data you obtained to the table below.

	First temperature	Temperature at the 5th minute	Temperature at the 10th minute
Unheated water's			
Heated water's			

Add ice into the heated and unheated water. Has there been any change in the ice? What kind of change happened, if any?

You have measured the temperatures of the waters at different times. Were their temperatures always the same? Why?

Let's Reach the Conclusion: Which characteristic of two materials need to be different for them to exhange heat?

Let's try to answer the questions below by means of what we have learned.

- What is the reason behind feeling cold when our hand touches snow?
- What are the fields of profession and lines of business related to the concepts of heat and temperature?

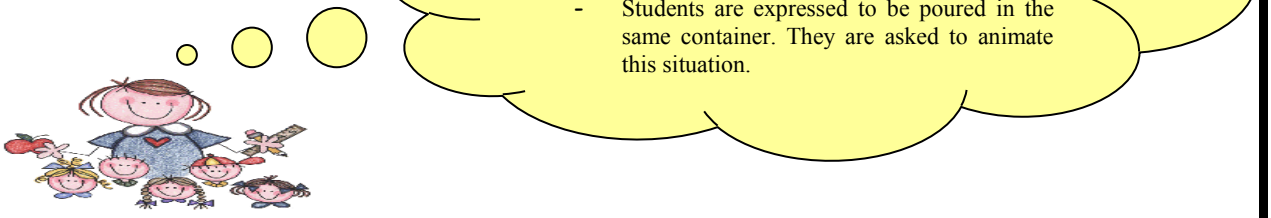
Appendix 3: Material used in the Cooperating step

HEAT EXCHANGE

Process:

Preparation / Heating

Activity 1



Explanation: The most important aspect which needs to be paid attention to here is to not intervene in the animations to be done by students. They should be ensured to use their bodies however they want.

Animation: Berk and Mert are two good friends. They sit at a cafe and order cola. While Berk orders a cold cola, Mert does not order a cola from the refrigerator. Because his throat is sore. The waiter brings the colas and empty glasses they ordered. However, Berk's cola is colder than he wanted while Mert's cola is too warm. They both complain as their colas are not at their desired temperatures. Mert finds a solution to this problem. Now, they both state that their colas at their desired temperatures. Students are asked to improvize on this subject.

Mid-assessment:

A mid-assessment is carried out here. Students are ensured to discuss with the questions below.

1. Who were in the animation?
2. What have we watched?
3. What kind of a solution Mert might have found in your opinion?

Assessment/Discussion

- Mothers boil milk for their children. They place the milk glass in cold water before making their children drink boiled water. What is the reason behind this?

Appendix 4: Material used in the Transferring step

Example 1:

Emir Berk sets off to go to his friend Yusuf's house on a winter day. Emir Berk gets quite cold. When he arrived at Yusuf's house, Yusuf opens the door. Yusuf shakes hands with Emir Berk. When Emir Berk shakes the hand of his friend Yusuf, he notices that his friend's hand is warmer than his and his hand warms as well. Emir Berk begins to think how his hand started to warm up. What kind of conclusion should Emir Berk reach from this situation in your opinion? Please explain.

Example 2:

The concepts of heat and temperatures have different meanings. While heat is a type of energy, temperature is a measurement.

Think of a burning matchstick and the sea. What can you tell about the heat and temperature of the matchstick and the sea?