THE EFFECT OF INSTRUCTIONAL COMICS ON SIXTH GRADE STUDENTS' ACHIEVEMENT IN HEAT TRANSFER

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ABSTRACT

THE EFFECT OF INSTRUCTIONAL COMICS ON SIXTH GRADE STUDENTS' ACHIEVEMENT IN HEAT TRANSFER

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The purpose of this study is to investigate the effects of instructional comics on sixth grade students' achievement in heat and temperature. The population of the study was all of the sixth grade students in public elementary schools in Yüzüncü Yıl district. The sample of the study was 113 sixth graders from three public elementary schools in Yüzüncü Yıl district. In the beginning of the matter and heat chapter of science and technology course, the implementation started with the pretest. Then, a series of comics were implemented to the students for two weeks. Then, the implementation ended with the posttest. Data were analyzed through MANCOVA where the independent variable is the treatment implemented to the students. The dependent variables are students' achievement in heat transfer, enjoyment of science and perception of success in science. It was statistically found that there is no significant effect of the treatment on the combination of the dependent variables. However, when the effects of the treatment on the dependent variables is investigated separately, it was found that students in the treatment group got significantly higher scores than the students in the control group. On the other hand, it was also found that there is no significant difference in students' enjoyment of science and their

perception of success in science between the groups. In addition, it was observed that instructional comics increase the participation of reluctant students.

Keywords: Instructional Comics, Storytelling, Science Achievement.

ÖZ

EĞİTİCİ ÇİZGİROMANLARIN ALTINCI SINIF ÖĞRENCİLERİNİN ISI TRANSFERİ KAVRAMINDAKİ BAŞARISI ÜZERİNDEKİ ETKİLERİ

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Bu araştırmanın amacı eğitici çizgiromanların altıncı sınıf öğrencilerinin ısı ve sıcaklık kavramlarındaki başarısı üzerindeki etkilerini sınamaktır. Bu çalışmanın evreni Yüzüncü Yıl semtinde bulunan kamuya ait ilköğretim okullarındaki tüm altıncı sınıf öğrencileridir. Çalışmanın örneklemi ise Yüzüncü Yıl semtindeki üç ilköğretim okulunda okuyan 113 altıncı sınıf öğrencisidir. Çalışma, öntestin fen ve teknoloji dersi madde ve ısı ünitesinin başında uygulanmasıyla başlamıştır. Sonra, deney grubundaki öğrencilere iki hafta boyunca bir dizi eğitici çizgiroman uygulanmıştır. Daha sonra, çalışma sontest uygulamasıyla sonlandırılmıştır. Elde edilen veriler MANCOVA kullanılarak analiz edilmiştir. Bu analizde bağımsız değişken öğrencilere uygulanan öğretim yaklaşımıdır, bağımlı değişkenler ise öğrencilerin ısı transferi kavramındaki başarısı, fenden hoşlanma düzeyi ve kendilerinin fendeki başarı algılarıdır. Sonuçlar uygulanan öğretim yaklaşımının bağımlı değişkenlerin bileşkesi üzerinde bir etkisinin bulunmadığını göstermiştir. Ancak, bağımsız değişkenin bağımlı değişkenler üzerindeki etkileri ayrı ayrı incelendiğinde, deney grubundaki öğrencilerin kontrol grubundakilere göre daha yüksek bir başarı düzeyine ulaştıkları görülmüştür. Öte yandan, iki grup

arasında fenden hoşlanma ve fendeki başarı algısı açısından anlamlı bir fark bulunamamıştır. Buna ek olarak, çizgiromanların isteksiz öğrencilerin derse katılımını artırdığı gözlemlenmiştir.

Anahtar Sözcükler: Eğitici Çizgiroman, Öykü Anlatımı, Fen Başarısı.

To My Son, Altay

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CHAPTER 1

INTRODUCTION

One of the most important issues in science education is that after 12 year science instruction, many of the students graduate from secondary school with many misconceptions about science. According to Sözbilir (2003), heat transfer is among the most problematic science concepts in which students have learning difficulties at various graduate levels. When the literature about the instruction of heat transfer is reviewed, it is observed that most of the studies focused how to detect and/or eliminate the alternative conceptions in heat and temperature. Tiberghien (1993) reviewed students' conceptions in heat and temperature in various research studies and concluded that there is a deep gap between students' knowledge structure and teaching content structure especially in heat and temperature. In addition, Aydoğan, Güneş and Gülçiçek (2003) identified that high school and university students have many misconceptions about heat and temperature. The researchers concluded that traditional approaches in science instruction clearly failed to eliminate these misconceptions. Therefore, the researchers suggested that science instruction should not be consider students as clean white boards. In other words, instructional approaches should especially deal with students' preconceptions about science and ways of changing them. The present study offers the use of comics in science instruction claiming a better leaning environment for this problematic concept.

Another important issue in science education is that traditional instructional

approaches cause a negative image of science. According to Türkmen (2008), most of the students think that science is a dangerous action which is carried out by serious people in laboratories. This image unavoidably creates prejudices about science lessons and it probably cause failure of some students in science lessons. The present study offers the use of instructional comics which emphasize entertaining side of science.

Since ancient times, people have used stories and tales to transmit knowledge and to teach socially acceptable behaviors to their children. In addition, Hadzigeorgiou and Stefanich (2000) stated that ancient people tried to explain natural phenomena with mythological stories. For instance, ancient Greeks explained the relationship between volcanoes and earthquakes with giant creatures imprisoned under the mountains. Darvell (1997) reminded that we never forget our childhood tales or movies that we watched many years ago. Such a long-term learning should have some implications to education. Actually, storytelling is a very powerful teaching method, because, it makes learning contextualized and consequently meaningful (Hadzigeorgiou & Stefanich, 2000).

In modern times, stories are still being used in various formats, such as, storybooks, cartoon animations, movies etc. Comics are one type of the modern stories. Traditionally, comics usually have some messages to children, such as, solidarity, friendship, honesty and so on. On the other hand, some comics have been discussed with respect to their dangers on children's behaviors. It is obvious that children learn much from commercial comics published on numerous kids' magazines and newspapers. As a result, for years, comics have played the role of funny learning environment with either positive or negative contents.

As mentioned above, comics have played an important role in non-formal education. However, one may wonder if comics can be effective instructional

tools in formal education. When the literature is reviewed, it is observed that there are three main uses of comics and caricatures in instructional process; as a warm up activity, as an instructional activity, and as an assessment tool.

Comics were found as good warm ups in the literature. Cheesman (2006) explained how to use comic strips found in newspapers and magazines in science classrooms as attention getters and starter for critical thinking. According to this study, comics helped students to focus on lessons and to learn to think in critical way.

Comics can be created and directly used to teach a specific concept. Keogh and Naylor (1999) successfully used concept cartoons which are a special type of single frame caricature to create cognitive conflict in students' minds in order to make ready them for accommodate new concepts and to emphasize correct explanations of concepts among wrong alternatives. Concept cartoons are not unique form of instructional comics. Rota and Izquierdo (2003) created and used comics directly to teach biotechnology concepts in primary school level. According to the authors, comics are very effective instructional tools, because they combine two very rich forms of cultural expression: the literature and the art. In addition, the author states that reading comics is not a passive activity. Because, while reading a comic story, the reader should fill out the gaps between panels which needs an active thinking. Similarly, Olson (2008) created and used comic strips in science classroom as a teaching method to promote science literacy. In this study, these comic strips were implemented in science classes as instructional activities to read, think and discuss. The results showed that comic strips increase students performance only in some specific concepts. In addition, students were perceived comic strips funny and effective in learning.

Comics can also be used as assessment tool. Song, Heo, Krumenaker, and Tippins (2008) investigated in what ways comics can be used as assessment

tool in the classroom. The researchers stated that comics can successfully used as assessment tool in three way. Firstly, comics can be used to assess students' ideas they brought to classroom. In other words, comics can be implemented to assess myths and misconceptions. Secondly, students' learning difficulties can be assessed by comics. In addition, comics can be used to assess applications of students' learning to daily life. Similarly, Beard and Rhodes (2002) used comics as reflective tool in adult learning. In this study, the researchers used comics with empty balloons for capturing subjects' reflections. According to the results, comics are a good way of expressing feelings, anxieties, and other emotions which may not surface through traditional techniques.

When the literature is reviewed, it is observed that the most of the studies used comics and caricatures in the newspapers and magazines which are not especially created for instructional purposes. There are only a few experimental studies focused the instruction of a specific concept via comics especially created for teaching that concept. In addition, no studies about the use of instructional comics in heat transfer are observed in the literature. The present study contributes science education literature by filling this absence.

In this study, the concept of heat transfer were chosen as the focus subject. In this study, there are two main reasons for choosing the subject of heat transfer. The first reason is that heat transfer is relatively static concept which is appropriate for a medium composed of static illustrations. The other reason is that heat transfer is a very challenging subject for students which provides a chance of a better observation of students' learning difficulties and managing them using comics.

In this study, sixth grade students were chosen as subjects. There is a simple reason for choosing this specific grade level. The reason is that sixth graders are relatively away from the stress of nationwide high school entrance examinations. In other words, implementation procedures and results of a

research study performed in seventh and eighth grade classrooms are unavoidably affected by this stress.

1.1 Research Question

This study aims to explore the effects of instructional comics on sixth grade students' achievement in heat transfer. Formally, the research question is "what is the effect of the use of instructional comics on sixth grade students' achievement in heat transfer, their enjoyment of science and their perception of success in science in Yüzüncü Yıl district in Çankaya?"

1.2 Definition of Key Terms

Like all other research studies, this study has some important key terms needed to be explained. Explanation of these key terms will provide a better understanding for this study. These terms are described in the following sections.

1.2.1 Instructional Comics

A comic is a book or magazine, especially for children, which contains a set of stories told in pictures with a small amount of writing (Walter, Woodford and Good, 2008). In this study, a series of comics was used as an instructional activity. These instructional comics are similar to the commercial ones published on magazines or newspapers. However, comics used in this study carry some hidden academic messages. It means that instructional comics used in this study aimed to teach some science concepts through an indirect way. In other words, in these comics, instructional content was not exposed directly like in documentaries; instead, it was hidden behind the adventures of comic characters. More information about instructional comics of this study is available in the instrumentation part in Chapter 3.

1.2.2 Achievement in Heat Transfer

As mentioned above, this research study focused on the effects of instructional comics on six grade students' achievement in heat transfer. Achievement is defined as the action of accomplishing something (Walter, et al, 2008). In this research, achievement in heat transfer is the scores which are measured by the achievement test about matter and heat chapter of sixth grade science and technology course which is constructed in this study.

1.2.3 Enjoyment of Science

This study also focused on the effects of instructional comics on six grade students' enjoyment of science. Enjoyment is defined as the act of receiving pleasure from something (Walter, et al, 2008). In this research, enjoyment of science is a score generated by some items of the attitude scale constructed in this study.

1.2.4 Perception of Success

This study also focused on the effects of instructional comics on six grade students' perception of success in science. Success is defined as an event that accomplishes its intended purpose (Walter, et al, 2008). In this research, students' perception of their success is a score generated by some items of the attitude scale constructed in this study.

1.3 Hypothesis

In this study, in general, there was an achievement comparison between two intact groups of sixth grade students. In the first group, a series of comics was implemented as instructional activities, and in the other group, usual instructional activities which are suggested by science and technology curriculum were implemented. Details of implementation procedures are

explained in Chapter 3. In this study, it was naturally expected that comics group would have significantly higher scores than the control group. On the other hand, as mentioned above, this study was not only interested in achievement comparison between the groups, but also tried to emphasize the importance of creating a funny learning environment for the students who are actually children needing a funny childhood.

The first null hypothesis is that there is not a significant difference between the treatment and control groups on the linear combination of students' post achievement, post enjoyment and post perception of success in science when the effects of students' pre achievement, parents' educational level, home resources, students' pre enjoyment and pre perception of success in science are controlled.

The second null hypothesis is that there is not a significant difference between the treatment and control groups in students' post achievement in science when the effects of students' pre achievement, parents' educational level, home resources, students' pre enjoyment and pre perception of success in science are controlled.

The third null hypothesis is that there is not a significant difference between the treatment and control groups in students' post enjoyment in science when the effects of students' pre achievement, parents' educational level, home resources, students' pre enjoyment and pre perception of success in science are controlled.

The fourth null hypothesis is that there is not a significant difference between the treatment and control groups in students' post perception of success in science when the effects of students' pre achievement, parents' educational level, home resources, students' pre enjoyment and pre perception of success in science are controlled.

1.4 Significance of the Study

In the history of science education, several instructional methods and media offered by science education specialists to create a better teaching/learning environment. Each instructional method or medium is advantageous for different science concepts and different age groups. To find an appropriate method - media combination for a specific science concept and a specific age needs a huge literature of research studies. One of the aims of this study is to contribute science instruction literature by trying a specific method – media combination for a specific age group. This study did not offer a new instructional method or a new media. Rather, it tried to apply comics which is a common entertainment means combination of storytelling and illustrations in to science instruction. In other words, this study simply tried to introduce comics in to the instruction of heat transfer.

According to Sözbilir (2003) heat and temperature are one of the most difficult concepts for the students at elementary, secondary and university levels. In addition, Kırıkkaya and Güllü (2008) concluded that teachers and textbooks are not successful to prevent misconceptions about heat and temperature at elementary school level. In the light of these findings, it is clear that heat transfer is one of the most difficult science concepts and traditional instructional approaches fail to prevent or eliminate the misconceptions about this problematic concept. The present study tried to create a better learning environment for this problematic science concept by using instructional comics.

A new instructional approach should aim to reach higher achievement grades in order to state it has a real and practical contribution to the instructional process in the classroom. Therefore, this study mainly aimed to increase sixth grade students' achievement in heat transfer. However, achievement should not be single unique focus in instructional process. A new instructional approach

should also create an entertaining atmosphere in the classroom. Because, childhood is and should be a funny period of life which is full of games and other entertaining activities. It is obvious that education system in our country is excessively stressful because of many nationwide examinations to enter next levels of education. On the other hand, it is also obvious that traditional instructional approaches do not emphasize the entertaining side of science. Actually, according to Türkmen (2008), most of the students think that science is a dangerous action which is carried out by serious people in laboratories. Therefore, this study also aimed to create a classroom atmosphere in which students enjoy learning science by using a set of funny comics.

CHAPTER 2

LITERATURE REVIEW

After reviewing the literature, it was observed that previous studies touched on different parts of the present study. Therefore, the review of the literature had resulted in four groups of studies which are partially related to this study. The first group includes studies about storytelling which is a frequently used teaching technique in science courses. The second group of studies focuses on the use of cartoon animations in instructional process. The third group of studies is related to the use of comics in instructional process. In addition to these groups of studies, as a forth group, studies about instruction of heat transfer are discussed in the following sections.

2.1 Storytelling in Education

To understand storytelling better, the discussion should start with the origins of it. Hadzigeorgiou and Stefanich (2000) reminded ancient relationship between storytelling and science. They stated that science and storytelling seem unrelated to each other, because, science is about objective and true knowledge and stories are about imaginary and unreal knowledge. However, they also underlined that the oldest theories about nature are based on pre-scientific myths. In other words, ancient people tried to explain natural phenomena with mythological stories. For instance, ancient Greeks explained the relationship between volcanoes and earthquakes with giant creatures imprisoned under the mountains. The authors also stated that myths and stories of past became

today's scientific theories.

In the frame of education, Darvell (1997) explained the importance of stories and storytelling through her personal experiences. The author calls our attention to the power of stories by the statement that "we never forget our childhood tales or movies that we watched many years ago". Such a long-term learning should have some implications to formal education. Similarly, McLellan (2006) stated that using storytelling makes the information tangible and memorable. The author also expressed that stories generally originate in problematic situations, therefore they show the way of solutions of these problems. In addition, according to McLellan (2006), stories are marvelous tools of summarizing experiences with their surrounding context. Also, the author explained that stories are cognitive tools encapsulating knowledge, context and emotions into a compact package.

It is well known that storytelling really works in class. However, "why and how does it work" is still a question mark. Hadzigeorgiou and Stefanich (2000) mentioned about Bruner's thoughts of storytelling. The authors stated that children learn much through storytelling, because it creates a context in their minds. Learning in context has a very important role in students' understanding, because, context makes learning meaningful. Similarly, Russo (1997) stated that children's science experiences throughout the curriculum should be relevant, meaningful and contextualized. Therefore, according to the author, stories are appropriate tools for science instruction. On the other hand, Heo (2004) expressed that storytelling is appropriate for teaching or learning environmental ethics, because stories can build a rich context in which students can make sense the external world and enhance environmental ethics in an indirect way.

In literature, it was observed that another use of storytelling is to enhance creativity of students. Alaba (2007) investigated the effect of comics on

primary school students creativity. Results showed that the use comics enhance the creativity of primary pupils. According to the author, comics are not only creative in nature, they also provide an environment allowing students explore with no restrictions.

Another use of storytelling in instructional process is as an assessment tool. McKillop (2005) argued that storytelling can be used to support reflection skills of students in higher education. The researcher stated that students tell many stories related to their experiences everyday which can be used as the basis for reflection discussions. The researcher used an online medium to elicit students' stories about assessment processes. According to the results of this research study, students' stories contains valuable information about their viewpoints, what they learned and what they wonder. The researcher concluded that using online storytelling environment enable students to share and learn from each other's experiences.

In addition to contextualized and meaningful learning, storytelling has some side benefits for instructional process. In his qualitative study, Groce (2004) have found that storytelling is effective in creating interest and improving reading skills of students. In addition, Hadzigeorgiou (2006) stated that stories have a potential to create anticipation, curiosity and sense of wonder in learning science. Also according to Redmond (2000), storytelling which has an ageless tradition is a rich resource to connect science to the other disciplines through various learning situations.

In real classroom settings, storytelling is found to be effective in science instruction. Davies (2005) observed that storytelling is especially beneficial in introduction of high level topics at lower classes. The author stated that level and depth of students' questions after storytelling session in genetics lesson was amazing. On the other hand, Silverstein and Tamir (1993) compared Story Animations and Documentaries about biology. They found that story animation

results with better knowledge gain and more positive attitudes than documentaries. However, they also found that story animation causes more misconceptions.

In storytelling technique, the students seem as passive listeners. At this point, one may ask whether it is a disadvantage of storytelling or not. Actually it depends how storytelling is implemented in the classroom. Russo (1997) made some suggestions for teacher to include students in stories. According to the author, students can name the story, they can contribute by their opinions, or they can dramatize it. In addition, Ohler (2005) suggested that students should create their own stories by using some e-tools. Similarly, Darvell (1997) stated that interactive stories in which students are not passive audiences are more effective in learning. The author also reported that story-building activities are more appropriate to older students.

2.2 Cartoon Animations in Education

It is a fact that children learn much from cartoon animations on television. For years, various types of this powerful tool have been used in teaching/learning process in formal education. According to Pearce (1999), animation is a great innovation in education to display some important concepts or principles that might not otherwise be able to shown in the classroom. For instance, speeding up naturally slow phenomena or slowing down naturally fast phenomena in animations can be effective on students' understanding. Pearce (1999) also reported the results of a survey about animation. According to the result of this survey, over 90 percent of 500 students found animations as effective or extremely effective in teaching/learning process.

One of the most popular uses of animation in education is as supplementary material of computer-based instruction. Ausman, Kidwai, Munyofu, Swain and Dwyer (2004) examined the effects of animation on higher order achievement

in a web-based programmed instruction on human heart. When designed and placed properly, the use of animation is found to be an important variable complementing web-based instruction, and it is found to increase overall achievement. However, it was also found that higher order achievement is not guaranteed even students have prerequisite knowledge. Similarly, Poohkay and Szabo (1995) compared animations, still graphics and texts in mathematics skills of drawing triangle on a group of 147 undergraduate students. Results showed that animation group had significantly higher scores than graphics group, and graphics group had higher scores than text groups. In addition, according to attitude scores of three groups, results showed that animation and graphics group were equal and higher than text groups. Poohkay and Szabo (1995) inferred that animations were more appropriate for teaching motion-based concepts.

As discussed above, Silverstein and Tamir (1993) compared two types of animation in biology teaching; story animations and documentary animations on TV. Results showed that TV broadcasts carrying biological concepts resulted in significant knowledge gains in both form. In addition, it was found that story animation leads to better knowledge gain and attitude but more misconceptions than documentaries. The researchers concluded that perception of visuals does not depend only on the factors related to sight. In other words, the researchers claimed that the students see what they believe which means an innocent eye does no exist. On the other hand, Fisch, Yotive, Brown, Garner and Chen (1997) compared educational and non-educational cartoon animations about prehistoric era. Results of this study indicated that children do not distinguish between educational and non-educational cartoon animations with respect to their content. In other words, children think that educational and non-educational cartoons are not different from each other. Actually, they watch educational and non-educational cartoons only for fun, however, they learn from both.

Cartoon animations on television contain intentionally or unintentionally some science concepts. Perales-Palacios and Vilchez-Gonzalez (2005) examined the use of commercial cartoon animations as an instructional material in physics lessons in secondary school. In this study, some sequences taken from commercial cartoon animations were used for identifying and discussing fictitious phenomena, problem solving, assessment of the learning and increasing motivation and participation. The results showed that showing cartoons in the classroom positively changed students' attitude toward the subject, and it was observed that students' misconceptions show a certain parallelism to those on cartoon animations. According to the researchers, showing cartoons in the classroom can reduce the barrier between the school science and everyday knowledge. In addition to these findings, it was observed that the analysis of cartoons to identify non-physical events in it stimulated a critical view about the messages from television in the classroom.

To integrate science into society, it should be first ensured how the image of science for the individuals especially for the children is. Vilchez-Gonzalez and Perales-Palacios (2006) analyzed the image of science presented in cartoon animations and compared it with the image presented in the comics. In other words, the researchers monitored and analyzed 100 cartoon episodes broadcast in Spanish televisions and compared them with the results obtained from comics. The results showed that, although cartoon animations and comics have some differences, both present a distorted image of science and scientists. For instance, in those media, science is presented as a rigid work including a set of mechanical steps. In addition, in cartoon animations and comics, science is presented as only empirical work in which there are no theories. Also, science is presented as an individualist work which is not performed by groups or teams.

2.3 Comics in Education

For years, comics are frequently used for educational purposes. It is obvious that comics make teaching-learning process entertaining. Beside entertainment, researchers examined whether comics have more direct roles in teaching/learning process. When the literature is reviewed, it is observed that there are three main uses of comics and caricatures in instructional process; as a warm up activity, as an instructional activity, and as an assessment tool.

Cheesman (2006) explained how to use comic strips found in newspapers and magazines in science classrooms as attention getters and starter for critical thinking. According to this study, comics helped students to focus on lessons and to learn to think in critical way. The author also gave some clues for best use of comics. According to the Cheesman (2006), large and clear comics should be used in the classroom, and comics should be appropriate for age and background of the students. Similarly, Wolschke-Bulmahn and Gröning (1994) stated that comics can successfully be used to attract attention to environmental issues. Wolschke-Bulmahn and Gröning (1994) discussed how comics published in magazines and newspapers could be used in teaching environmental issues to the children. The authors concluded that children should be educated about nature protection issues with the sense of humor instead of the conscious of mission. In addition, Witkowski (1997) explained the reflections about scientific comics created by two famous comic artists: Sydney Harris and Nick Downes. According to Witkowski (1997) comics play an important role in communicating science in public, because humorous events in the comics makes science concepts simpler and more familiar. Similarly, Parsons and Smith (1993) described how commercial comic books can be used to stimulate students' learning. The authors believed that comics are very suitable for teaching geography and environmental issues. In addition, science fiction comic book were believed to be appropriate for teaching science and technology concepts.

Comics can be created and directly used for teaching a specific concept. Keogh and Naylor (1999) examined the use of concept cartoons in science lessons. A concept cartoon is a single frame illustration of a case including conflicting ideas. According to the authors, concept cartoons are beneficial for science teaching, because they create cognitive conflict in students' mind; therefore, they make students' ready to accommodate new knowledge. In addition, concept cartoons are also found to be beneficial to gain students' attention. Similarly, Kabapınar (2005) examined the effectiveness of concept cartoons in science teaching and learning. The author focused on students' misconceptions about science. The results showed that concept cartoon approach is effective in determining and remedying students' misconceptions about science. However, the researcher underlined that the success of this approach is not related to only concept cartoon itself but also classroom discussions used as additional activities. In addition, Keogh and Naylor (2000) explained their impressions about the use of concept cartoons from teachers' and students' experiences. Results showed that concept cartoons make students think about their own and others thoughts. Results also showed that teachers found concept cartoons beneficial in determining, challenging and developing students' ideas.

Concept cartoons are not unique form of instructional comics. Like in the present study, Rota and Izquierdo (2003) created and used comics directly to teach biotechnology concepts in primary school level. They tried to teach biotechnology concepts through the adventures of three comic characters who are a scientist, a girl and a dog. After implementation, it was observed that objectives of the course were reached successfully. According to the authors, comics are very effective instructional tools, because they combine two very rich forms of cultural expression: the literature and the art. In addition, the author states that reading comics is not a passive activity. Because, while reading a comic story, the reader should fill out the gaps between panels which needs an active thinking. Similarly, Rollnick et al. (1997) tried to incorporate

puppets and comics into primary science lessons. Produced material package included adventures of four comic characters and their puppets. These materials were evaluated by teachers and science educators. The results showed that science educators recognized comics and puppets as supplementary materials rather than main curriculum materials. Also, teachers' philosophy influenced the way of using these materials in the classroom. Similarly, Olson (2008) evaluated the use of comic strips in science classroom as a teaching method to promote science literacy. For this study, the researcher created a collection of comic strips about the adventures of two lab rats namely Newton and Copernicus. In this study, these comic strips were implemented in science classes as instructional activities to read, think and discuss. The results showed that comic strips increase students performance only in some specific concepts. In addition, students were perceived comic strips funny and effective in learning.

As well as learning activity, comics can also be used as assessment tool. Song et al. (2008) investigated in what ways comics can be used as assessment tool in the classroom. The researchers stated that comics can successfully used as assessment tool in three way. Firstly, comics can be used to assess students' ideas they brought to classroom. In other words, comics can be implemented to assess myths and misconceptions. Concept cartoons is a good example of this way of use. Secondly, students' learning difficulties can be assessed by comics. For instance, students may be asked to complete blank balloons in a dialog. This provide recognition students learning difficulties for teachers. In addition, comics can be used to assess application students' learning to daily life. For example, students may be asked to make a comic story project about science concepts. Similarly, Beard and Rhodes (2002) used comics in assessment process. The researchers examined the use comics as reflective tool in adult learning in M.S. degree outdoor management development program. In this study, the researchers preferred using pre-prepared comics with empty balloons for capturing subjects' reflections. According to the results, comics are a good

way of expressing feelings, anxieties, and other emotions which may not surface through traditional techniques.

In the literature, it was observed that one of the advantages of comics is about its relationship with reading comprehension. Williams (1995) stated that commercial comic books can successfully be used as course book in English as a second language courses. Similarly, Jones (2004) stated that children give up reading books after exposure to traditional school-mandated literature. According to National Education Association (NAE), most people do not willingly read any novels, stories or poems. However, the author reminded that the same children read millions of comic magazines each month in the USA. In this country, kid readers buy 36 million and teen readers buy 16 million comic magazines each month. After considering these huge statistics, Jones (2004) concluded that comics have save us from illiteracy as well as streaking comets, alien invasions and exploding stars. According to the author, NAE obviously does not consider comic books and magazines as serious reading materials, however, comic books are a kind of work of art and literature telling about our wold. In addition, Muniran and Yusof (2008) suggested using comics and graphic novels in schools and libraries to promote literacy among undeveloped children because their dynamic style and presentation with visual storytelling make them more interesting than textbooks and make it possible to deliver heavier content in a simpler way. In addition, Liu (2004) investigated the role of comic strips in reading comprehension of English learners through an experiment. The results showed that beginner level students receiving high-level text with comic strip gained score significantly higher than the students receiving high-level text only.

It is a fact that comics are cheap among a variety of instructional media. Trent and Kinlaw (1979) stated that comics are suitable learning tool for educationally and economically disadvantaged children. In addition, according to Beard and Rhodes (2002) , comics are advantageous in communicating

information, simplifying instructions, stimulating discussions and being a mnemonic tool for cognitive retention.

2.4 Instructional Issues about the Concept of Heat Transfer

When the literature about the instruction of heat transfer was reviewed, it was observed that most of the studies focused how to detect and/or eliminate the alternative conceptions in heat and temperature.

Tiberghien (1993) reviewed students' learning and conceptions in heat and temperature in various research studies in order to interpret students' learning difficulties. The results showed that there is a deep gap between students' knowledge structure and teaching content structure especially in heat and temperature. Similarly, Sözbilir (2003) reviewed some of the studies about the students' understandings of heat and temperature in order to summarize the misconceptions and possible sources of these misconceptions. The results indicated that heat and temperature are clearly among the most difficult concepts for the students at elementary, secondary and university levels. Because, young children's conceptions about heat and temperature are very similar to the conceptions of university students. In addition, Aydoğan, Güneş and Gülçiçek (2003) tried to identify the misconceptions of high school and university students about heat and temperature. The results showed that high school and university students have many misconceptions about heat and temperature. The researchers concluded that traditional approaches in science instruction clearly failed to eliminate these misconceptions. Therefore, the researchers suggested that science instruction should not be consider students as clean white boards. Actually, these boards contain very much prior knowledge and prejudices. The researchers also suggested that science instruction should start with the students' realization of their pre-conceptions and prejudices. Similarly, Kırıkkaya and Güllü (2008) tried to identify the misconceptions of fifth grade elementary school students about evaporation

and boiling. The results of the study indicated that more than half of the students think that water can only evaporate when it boils. The researchers concluded that teachers and textbooks are not successful to prevent misconceptions about boiling and evaporation at elementary school level. Some special additional activities should be implemented for remedying these misconceptions.

Erickson (1979) reviewed and summarized children's important conceptions of heat and temperature. Students' conceptions about the nature of heat are listed below.

- There are two types of heat; hot and cold.
- Heat is like a wave that rises up from the road. It looks like fumes.
- Heat travels through all substances.
- Heat comes from any object that is hot.
- Everything contains air bubbles. Some of the bubbles might contain hot air and some cold air.

As well as heat, students have also many pre-conceptions about temperature. Students' conceptions about temperature are listed below.

- The temperature of an object depend upon the amount of heat (fumes) it contains.
- An object cools when it gives off some of its heat as fumes.
- Many students are unable to distinguish between heat and temperature.

- Temperature is a measure of the mixture of hot and cold inside an object.

- All objects contain a mixture of hot and cold.

- When two glasses of water are combined, the final temperature of the water can be calculated by adding the temperatures of the the two original glasses of water.

- The temperature of an object depends on the size.

- Soft materials melt more easily.

Some of the studies in the literature not only identified students' misconceptions about heat and temperature, but also tried to eliminate them in the instructional process. Başer and Çataloğlu (2005) tried to identify the effect of conceptual change instruction on seventh grade students' understanding of heat and temperature. In their experimental study, the researchers found that there is no significant difference in students' attitude toward science and their understanding of heat and temperature between the experimental and control groups. Similarly, Coştu (2007) tried using predict-discuss-explain-observe-discuss-explain (PDEODE) strategy to help students making sense of everyday situations about heat concepts. PDEODE is a six-step teaching strategy which provide an instructional atmosphere supporting diversity of views in the classroom. The results showed that PDEODE is an effective teaching strategy. Also, the strategy provides students a chance of examining their classmates' experiences and conceptions. In addition, the strategy was found to be effective in eliminating students' misconceptions about heat and temperature. In addition, Asan (2007) aimed to determine the effects of computer based concept mapping on fifth grade students' achievement in heat and temperature. The experimental treatment is asking students to create a concept map about

heat and temperature summarizing the chapter by using a concept mapping software namely Inspiration. The results showed that concept mapping has an important effect on students' achievement.

There are several factors affecting students' misconceptions. Magnusson and Krajcik (1993) tried to identify the effects of teachers' pedagogical content knowledge and content-specific knowledge in the instruction of heat and temperature. The results showed that teachers do not have differentiated knowledge about topic-specific instructional activities with respect to the difference between heat and temperature. According to the researchers, this result has some important implications for pre-service and in-service teacher preparation. Historical persistence of beliefs is a natural outcome of experience with the world. This knowledge may be useful for evaluating and choosing appropriate instructional activities. In other words, teachers should carefully evaluate instructional activities with respect to conceptual issues the student are likely to have.

2.5 Summary

As mentioned above, review of related literature had resulted in four groups of studies which are partially related to the present study. In the first group, studies about storytelling were reviewed. In literature, storytelling was found to be one of the oldest and most effective communication and teaching methods. The reason for the effectiveness of this method was reported that it makes learning contextualized and consequently meaningful. This great effect of storytelling is one of the most important advantages of it. In literature, it was also reported that students are passive listeners in storytelling, and this is one of the most important disadvantage of it.

In the second group, studies about cartoon animations in education were reviewed. Actually, there are innumerable studies about the use of animations

in education. However, most of them focus on the use of simulation type animations for specific academic contents which is not found closely related to the present study. Therefore, in this review, only the studies about cartoon animations were included. On the other hand, a few studies about the general advantages of animations were reviewed. In literature, it was reported that animation is a great innovation in education to display some important motion based concepts and principles that might not otherwise be able to shown by means of traditional instructional materials in the classroom.

In the third group, studies about comics in education were reviewed. Most of the studies in the literature investigated famous comics in the magazines and newspapers which have not prepared for the instructional purposes. A few of the studies in the literature tried to construct comics especially for the instructional purposes just like the present study. It is obvious that comics make teaching-learning process funny. Besides fun, comics, especially concept cartoons, were found to be an effective instructional approach. It was reported that the reason for the effectiveness of concept cartoons is their cognitive conflict approach. In addition, size, clearness and the appropriateness of the comics are significant in the implementation. Concept cartoons are not unique form of comics in education. Comic stories were also found to be effective instructional materials. Because, comic stories combine two very rich forms of cultural expression: the literature and the art. In addition, comics can also be used to assess students' misconceptions and learning difficulties.

In the fourth group, the studies about students' misconceptions in heat and temperature were reviewed. It was observed from the literature that heat and temperature are among the most difficult concepts for the students from all graduate levels. In addition, it was also observed that traditional instructional approaches definitely failed to eliminate students' misconceptions. In order to eliminate students' misconceptions about heat and temperature, the literature suggested the use of instructional approaches in which students realized their

own misconceptions, such as conceptual change instruction, concept mapping.

The review of related literature had some important implications to this study. In this study, the advantages of storytelling, comics and concept cartoons and alternative approaches to eliminate students' misconceptions were benefited in order to construct effective instructional comics to create an effective learning environment. On the other hand, this study has a contribution to the literature of educational comics. Most of the studies in the literature examined the instructional use of commercial comics which are not originally prepared for instructional purposes. However, in this study, the effects of a series of comics which are especially created to be used in the instructional process of heat transfer.

CHAPTER 3

METHODOLOGY

3.1 Research Design

This is basically an experimental study in which there is an treatment and a control group. The experiment was performed in intact groups; therefore, there is not a random assignment which is a basic requirement for true experimental designs. However, there were some statistical control mechanisms during the analysis. Therefore, this study is a quasi-experimental design. Figure 3.1 describes structure of the study in brief.

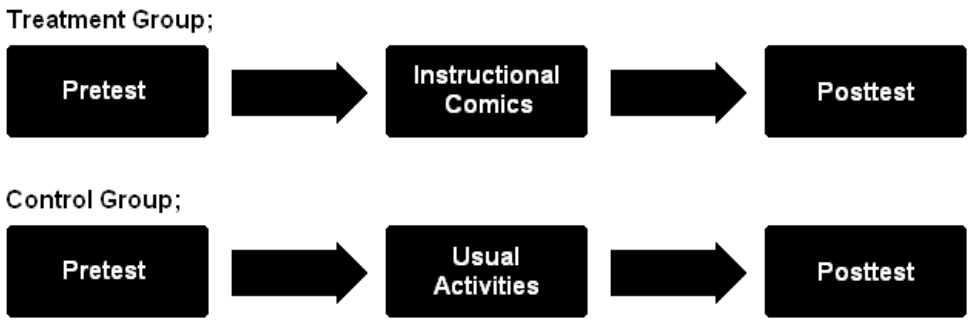

Figure 3.1 Research Design

As seen on the figure above, in treatment group, the implementation started with the pretest. In this group, after pretest, the treatment which includes instructional comics was implemented. The implementation in treatment group ended with the posttest. In the control group, instead of instructional comics, usual continuing classroom activities were implemented, such as; experiments, demonstrations.

3.2 Population and Sample

This study wants to generalize its results to a specific population. Therefore, an appropriate sampling procedure were done during the study. Description of population and sampling procedures are explained in the following sections.

3.2.1 Target and Accessible Population

Target population of this study is all sixth graders in Turkey. However, such a huge population is almost impossible to be represented by a sample chosen in a single experimental study. Therefore, the population which is accessible to this study is all sixth graders from public elementary schools in Yüzüncü Yıl district in Çankaya.

3.2.2 Sampling Procedure

The experiment was performed in intact groups in some elementary schools. Therefore, the sample of the study was chosen through convenience sampling. First, three public elementary schools was chosen, and then, two classes of the same teacher were chosen from each school. One class was assigned as treatment group, and the other class was assigned as control group in each school.

Intact groups are generally problematic for experiments. Because, an experiment performed in intact groups lacks random assignment that is a

fundamental property of true experimental designs. Therefore, in this quasi-experimental study, there were some procedures to show equivalence of experimental and control groups.

3.2.3 Sample Size

Sample size of a research is decided before the study through the consideration of size of the population, power, alpha and effect size and some additional factors related to statistical analysis. To decide sample size for specific power, effect size and alpha values, Cohen's table is used. Where alpha is 0.05, power is 0.80 and effect size is medium, suggested sample size by Cohen's Table is 64. However, Cohen's table suggests a minimum value for sample size. The size of the population is another consideration for deciding sample size. To avoid the generalization problem, sample size should be about ten percent of the size of the population. Table 3.1 demonstrates detailed information about sample and population of sixth grade students in Yüzüncü Yıl district.

Table 3.1 Sample and Population

	Population	Sample	Percentage
Number of Schools	5	3	60
Number of Classrooms	13	7	54
Number of Students	272	113	42

As seen from this table, in this study, the population was represented more than fifty percent by the sample with respect to the number of school and classroom. In addition, size of the sample was 42 percent of the size of the population which implies a quite high level of representation. Formally, the sample of this

study is 113 sixth grade students from three public elementary schools in Yüzüncü Yıl district.

3.3 Materials and Instruments

In this study, a series of comics was used as instructional activities in treatment group. In addition, an achievement test were used in order to measure students' achievement. Also, a treatment checklist to check authenticity of the treatment, a student questionnaire to learn students' opinions about comics and a teacher questionnaire to learn teachers opinions about treatment were used. In addition, lesson plans were used as supplementary materials. In following sections, detailed information about each material and instrument is explained.

3.3.1 Instructional Comics

A series of comics was implemented as an instructional activity in this study. These comics was like those on newspapers and magazines. However, unlike regular commercial comics, the instructional comics of this study carried academic messages hidden behind the adventures of comic characters in the story.

In this study, a series of comic stories was prepared for the sixth grade matter and heat chapter. Matter and heat chapter were covered with six episodes of comics. Table 3.2 explains the relationship between instructional comics and objectives in the sixth grade matter and heat chapter in the science and technology curriculum.

Table 3.2 Instructional Comics and Objectives

Code No.	Objectives	Comics
	Student;	
O1	Concludes by observing that atoms and molecules move faster when the matter is heated.	1
O2	Relates heat transfer between objects and collisions between atoms/molecules.	1 (in discussion)
O3	Shows heat conduction in solid objects by experiment.	2
O4	Names solid objects which conduct heat well, as conductor.	2
O5	Names solid objects which do not conduct heat well, as insulator.	2, 5, 6
O6	Concludes by daily observations that heat can be transferred without direct contact.	4
O7	States that heat can be transferred by radiation (by lights that can not be seen by eyes)	4
O8	Explains why earth's surface becomes cold at nights.	4
O9	Explains why dark colored objects warms up faster than light colored objects.	6 (in discussion)
O10	Explains why heat insulation containers are painted with shining colors.	6
O11	Demonstrates heat transfer by convection in liquids by an experiment.	3 (in discussion)
O12	Distinguishes cases in which heat is transferred by conduction, convection and radiation.	6
O13	Estimates conditions in which heat insulation is needed.	5, 6
O14	Gives examples of conditions in which heat conduction is needed instead of heat insulation.	2, 5 (in discussion)
O15	Gives examples of materials commonly used in heat insulation.	5, 6
O16	Explains the relationship between heat insulation and energy consumption in buildings.	5

Instructional comics used in this study were created by the researcher who is also a comic artist. In the first step, a main comic character who is a repairman was identified. Repairman was chosen because he is a perfect problem solver in real life. In the second step, scenarios of six episodes were written by the researcher. In the third step, each episode was drawn and colored by using a pen tablet connected to a computer. Finally, balloons were written by using a computer software. In each episode, a repairman who lives in a small town solves people's problems, while explaining concepts of heat, conduction, convection, radiation, insulation and so on. Initial forms of instructional comics are available in Appendix A.

After the creation of comics, they were piloted in a small group of students in a public elementary school. In the pilot implementation, students mostly suggested that the amount of text in the comics should be decreased. In addition, they suggested that interactivity should be increased in the treatment. According to the feedback from pilot study, comics were re-created. After recreating the comics, each episode was reviewed by two experts who are academicians in science education. The experts suggested some changes in the appearance and text of the comics. For instance, one expert made a warning that the vibrations of atoms should be shown for all atoms, otherwise students may get a wrong idea that some atoms do not vibrate. According to this suggestion, all atoms shown in the comics drawn with vibration curves. All other suggested revisions and modifications were performed according to the expert opinions. With these modifications, final forms of comics included less text and balloon completing activities were introduced in order to increase interactivity. Final forms of instructional comics used in this study are available in Appendix B. Expert opinion form for instructional comics are available in Appendix C.

3.3.2 Achievement Test

In this study, an achievement test about matter and heat chapter was used in pre-test and post-test. This test was constructed by the researcher. Achievement test was composed of objective test items. Standard test construction procedures were followed during construction of achievement test. The steps of construction of achievement test are explained below.

In the first step, primary purpose of the achievement test was identified. The primary purpose of the achievement test was to measure sixth grade students' achievement in matter and heat chapter in the sixth grade science and technology lesson.

In the second step, behaviors wanted to be measured were identified for the test specification. Actually, objectives of the matter and heat chapter in the science and technology curriculum were used to prepare items. Table 3.3 demonstrates the objectives taken from the sixth grade science and technology curriculum.

In the third step, initial forms of multiple choice items were constructed according to objectives of the matter and heat chapter. Only multiple choice type items were used in the achievement test. As seen on Table 3.3, some objectives focuses on students' performance in an experiment or their conclusions in daily life experiences, which are hard to be measured by multiple choice items. Therefore, in this study, some objectives could not be measured properly. In other words, some objectives were reduced to be measured by multiple choice items.

Table 3.3 Objectives of the Matter and Heat Chapter and Related Items

Code No.	Objectives	Items
	Student;	
O1	Concludes by observing that atoms and molecules move faster when the matter is heated.	1
O2	Relates heat transfer between objects and collisions between atoms/molecules.	2
O3	Shows heat conduction in solid objects by experiment.	3
O4	Names solid objects which conduct heat well, as conductor.	4
O5	Names solid objects which do not conduct heat well, as insulator.	5, 6
O6	Concludes by daily observations that heat can be transferred without direct contact.	7
O7	States that heat can be transferred by radiation (by lights that can not be seen by eyes)	7
O8	Explains why earth's surface becomes cold at nights.	17
O9	Explains why dark colored objects warms up faster than light colored objects.	8
O10	Explains why heat insulation containers are painted with shining colors.	15
O11	Demonstrates heat transfer by convection in liquids by an experiment.	9
O12	Distinguishes cases in which heat is transferred by conduction, convection and radiation.	10, 11, 12
O13	Estimates conditions in which heat insulation is needed.	13
O14	Gives examples of conditions in which heat conduction is needed instead of heat insulation.	16
O15	Gives examples of materials commonly used in heat insulation.	5, 6, 14
O16	Explains the relationship between heat insulation and energy consumption in buildings.	14

After constructing items, the test was reviewed by two experts who are academicians in science education. The experts suggested some changes in the format and wordings of some items. For instance, one expert suggested that some questions should be converted from one answer to multiple answers type, because, in initial forms, the stem of some items were meaningless alone. Problematic questions were converted to multiple answers type. All other suggested revisions and modifications were performed according to the expert opinions. Expert opinion form for achievement test is available in Appendix D.

In the next step, achievement test was piloted in a small group of students. The subjects was chosen in a convenient group. This group was 62 sixth grade students from two classrooms of a teacher in a public elementary school. Initial form of achievement test was implemented to this group. Data from the pilot implementation were analyzed to determine problematic items. To make some modifications in achievement test, item analysis was performed. Below, Table 3.4 summarizes the results of item analysis.

Table 3.4 Results of Item Analysis in the Pilot Study

Statistics	Value
N of Items	15
N of Examinees	62
Mean	9.74
Variance	7.93
Std. Dev.	2.82
Median	10
Alpha	0.67
SEM	1.62
Mean P	0.65
Mean Item-Tot.	0.43
Mean Biserial	0.6

As seen from the table above, alpha value which represents reliability of the scores was not high. Therefore, it was decided to increase the number of items. Mean P value which represents difficulty of the test can be accepted as ideal. Mean Biserial value which represents discrimination of the test was high. In addition, one item which is Question 7 in the initial form of the test was found to be problematic in the distractor analysis. The problem was that one of the alternatives was marked more frequently than the correct alternative. When this alternative was examined, it was found to contain a partially true statement. Therefore, this distractor was changed. To see the results of distractor analysis, check Appendix E. Initial form of achievement test is available in Appendix F and final form of the achievement test is available in Appendix G.

This study needed supplementary information about students' socioeconomic status, their enjoyment of science and their self perception of success which possibly have significant effects on students' achievement. In order to use in this study, 15 items about these three dimensions were adapted from TIMSS questionnaire. In the first part of the test paper, these items were used as background questions to get supplementary data for statistical analysis. These background questions are available in Appendix G.

3.3.3 Open Ended Questionnaire for Students and Teachers.

In this study, students' achievement in heat transfer before and after treatment was analyzed statistically. However, a deeper consideration of students' opinions about comics through an open ended questionnaire might be useful for understanding the real situation in the classroom during the treatment. Therefore, an open ended questionnaire for students was constructed to collect deeper information about students' opinions about instructional comics. In this questionnaire, students were asked about whether comics can make teaching/learning process more funny, whether comics can provide a better learning, advantages and disadvantages of instructional comics and how

instructional comics can be improved.

In addition to students, the teachers might also have some important feedback for the study. Therefore, an open ended questionnaire for the teachers was constructed. In this questionnaire, in addition to students' one, teachers were asked about the effects of instructional comics on classroom management, participation, gender differences, socioeconomic differences among students. Open ended questionnaires for students and teachers were implemented by the researcher. Open ended questionnaires for students and teachers are available in Appendix H and Appendix I, respectively.

3.3.4 Lesson Guides

Before the implementation of treatment, each lesson was planned in detail by the researcher. Lesson guides were prepared in order to ensure that the teachers understand what the treatment is and how it should be implemented. The treatment was planned to take eight lessons in two weeks. The first and the last lessons were assigned to the implementation of pretest and posttest. Remaining six lessons were assigned to the implementation of instructional comics. Therefore, six lesson guides were prepared for this treatment. Each lesson guide includes some directives and warnings about the implementation of the instructional comics in the lessons. The directives and the warnings were generated by the researcher with respect to the review of the related literature and modified according to the expert opinions and pilot implementation. For example, in the first episode of the comics, the atoms were illustrated as small balls near a microbe. However, they actually were unrealistically huge when the size of the microbe is considered. Therefore, one of the experts made a suggestion that a warning about the unrealistic size of the atoms should be placed in the related lesson guide. Before the implementation, lesson guides were explained to teachers. Teachers used them before and during the lessons to reach intended authentic treatment of the study. Lesson guides are available

in Appendix J.

3.3.5 Treatment Checklist

In order to check authenticity of the treatment and to ensure the internal validity, a detailed treatment checklist was prepared by the researcher. The checklist included some items about treatment and data collection procedures. The treatment checklist was constructed mainly according to the lesson guides, because the treatment implemented in real classroom should be close to intended treatment on lesson guides as much as possible. The treatment checklist was also constructed according to possible threats to internal validity in order to avoid unintended events that may affect the results. The treatment checklist was implemented by the researcher during the observation of treatment and data collection in the classroom. It was also used by the teachers after the lessons for self evaluation. Treatment checklist is available in Appendix K. In addition, the results of the treatment verification is explained in Chapter 5.

3.4 Procedures

In this study, standard quantitative research procedures were performed. After defining the research problem and hypothesis, materials and instruments were constructed first. Then, these materials and instruments were piloted in a small group. After pilot study, some modifications in comics and achievement test were done. Then, final forms of instruments were implemented in a larger group. And finally, data from main implementation were analyzed and interpreted. The procedural steps of this study are listed below and each step is described in the following sections in detail.

1. Construction of Materials and Instruments

2. Pilot Study and Revisions

3. Implementation of Treatment

4. Data Analysis

3.4.1 Construction of Materials and Instruments

The procedures of this study started with writing of scenarios of instructional comics. These scenarios were prepared by the researcher according to the objectives of matter and heat chapter in the science and technology curriculum. After writing scenarios, comics were drawn by the researcher who is also a comic artist. Then, completed comics were evaluated and criticized by two science educators. These experts suggested some modifications about appearance and text in the instructional comics. Initial and final forms of instructional comics used in this study are available in Appendix A and B, respectively.

On the other hand, an achievement test was constructed by the researcher. Standard test construction procedures were implemented for the preparation of achievement test of this study. Initial and final forms of achievement test used in this study are available in Appendix F and G. In addition, a treatment checklist was constructed by the researcher to check the authenticity of the treatment. Treatment checklist is available in Appendix K. Also, open ended questionnaires for students and teachers were constructed to collect deeper information about instructional comics. Open ended questionnaires are available in Appendix H and I. In addition, lesson guides were constructed to train teachers before the implementation of the treatment. Detailed information about constructing procedures of these instruments are given in the previous section.

3.4.2 Pilot Study and Modifications

Pilot study was a complete implementation of the research on a small group. The group of subjects was chosen in a convenient group. This group was 62 sixth grade students from two classrooms of a teacher in a public elementary school. One of the classrooms was assigned as treatment group, the other classroom was assigned as control group. The achievement test and instructional comics were piloted in this group.

After teacher training, pilot study started with the implementation of the initial form of achievement test as pretest. Then, initial forms of six instructional comics were implemented in six consecutive lessons for two weeks. Each lesson started with 10 minute comics reading session. After reading comics, the teacher guided a discussion by asking predefined questions about comics for the next 20 minutes. After discussion, the teacher summarized the science topic of the lesson. Pilot study ended with the implementation of achievement test as posttest.

Some useful feedbacks from students and teacher about treatment and procedures were obtained in the pilot study. An important feedback was that reading comics is a passive activity, it should be modified to become more active. Another important feedback was that fast readers read comics quickly, and then wait for the others which is a boring period. The activity should be modified to prevent this situation. According to these feedbacks in the pilot study, necessary modifications in the treatment and procedures were performed, such as, instructional comics were recreated to be suitable for blank balloon completing activity.

3.4.3 Second Pilot Study

One year after the pilot study, the experiment was re-performed in a larger

group of students. In this implementation, the sample was 141 sixth grade students from six classrooms of a teacher in a public elementary school in Sokullu Mehmet Paşa district in Ankara. Three classrooms were assigned as treatment group and the other three classrooms were assigned as control group.

This study started with the implementation of the pretest in both groups. After pretest, instructional comics recreated in the first pilot were implemented in the treatment group. After the treatment, the posttest and open ended questionnaires were implemented. During the implementation of posttest in a treatment classroom, the teacher was called urgently by the school principal. After the teacher left the classroom, test atmosphere was corrupted and the assumption of independent measurements was seriously violated. Therefore, this classroom were excluded from the analysis. ANCOVA was used to compare the achievements of the treatment and the control groups where the effect of students' pretest scores was controlled.

The results showed that the posttest scores of treatment group are significantly higher the scores of control group where p is equal to 0.018. In addition, effect size of the treatment is small where partial eta squared is equal to 0.046 and power of the analysis is moderate where observed power is equal to 0.659.

This second implementation of the experiment had an important feedback for the study. To get more reliable and powerful results in the main implementation, the number of questions in the achievement test was increased.

3.4.4 Implementation of Treatment and Data Collection

In this experimental study, there was a treatment and a control group. In the treatment group, a series of comic stories was implemented as instructional activities. Before treatment, the teachers were trained about instructional

comics and their implementation. Also, a set of lesson plans were delivered to teachers. The treatment started with the implementation of pretest in first lesson of the first week. During two-week treatment, six instructional comics were implemented in six lessons. The treatment finished with the implementation of posttest in the last lesson of the second week. Meanwhile, in the control group, a usual two-week treatment which can be described as expository teaching integrated with projects were implemented.

In the treatment group, there were three phases of treatment in each lesson. In the first phase, teacher informed students about activities in the lesson, and then students read a comic story and complete the blank balloons for ten minutes. In the second phase, teacher asked some students to summarize what they read in the story without explaining the blank balloons. And then, teacher asked many students to explaining what they write in the blank balloons. In this phase, a discussion atmosphere in which conflicting ideas of students come across were created in the classroom. In this phase, students learned correct statement for blank balloons. In the third phase, teacher summarized the topic briefly at the end of the lesson. Description of proposed experimental treatment is given in Figure 3.2.

Figure 3.2 Description of Experimental Treatment

In this study, data from various sources were collected at different times. In the beginning of the study, the pretest including the achievement test and some background questions was implemented by the researcher. During the

treatment, the researcher played the role of observer and used a checklist to ensure the authenticity of the treatment. At the end of the treatment, the post-test which is equivalent of pretest was implemented by the researcher. In addition, in order to get some deeper feedbacks, the researcher implemented open ended questionnaires to the students and the teachers after the treatment.

3.4.5 Data Analysis

In this study, there were various sources of data listed below.

- Data from achievement test and background questions (Pretest and Post-test)
- Data from open-ended questionnaires of students and teachers
- Data from balloon completing activities
- Data from treatment checklist filled by the researcher and the teachers

Data from pretest and post-test were collected for the primary analysis of the study. These data were mainly analyzed through MANCOVA. In this study, covariate analysis were used, because the groups were not assigned randomly. There is always a risk that treatment and control groups may not be equivalent if intact groups are used. Covariate analysis excludes the effects of variables that are possible sources of inequalities between treatment and control groups. Therefore, if it is used properly, this analysis may reduce the disadvantage of intact groups. Dependent and independent variables of this study are illustrated in Table 3.5 below.

Data from open ended questionnaires with students and teachers were analyzed qualitatively to get deeper information of students' and teachers' opinions

about the effects of animated cartoons on science achievement. The data were used to make inferences about how students and teachers experienced the treatment and what they really think about it.

Table 3.5 Variables of the Study

Dependent Variables	Independent Variable	Covariates
Students' Post Achievement in Heat Transfer (POSTACH) Students' Post Enjoyment of Science (POSTENJY) Students' Post Perception of Success in Science (POSTSUCC)	Treatment (TRE)	Students' Pre Achievement in Heat Transfer (PREACH) Students' Pre Enjoyment of Science (PREENJY) Students' Pre Perception of Success in Science (PRESUCC) Parents' Education Level (PARED) Home Resources (HOMER)

Most of the students completed blank balloons correctly, however wrong

statements in the blank balloons had some implications for this study. Therefore, wrong statements in the blank balloons were detected and interpreted qualitatively.

Data from treatment checklist were analyzed through descriptive statistics. The analysis of data from treatment checklist provided evidences for the internal validity of the study. In other words, the analysis of the data from treatment checklist was done to check whether the treatment has been performed in its authentic form and data collection procedures was fair or not.

3.5 Validity of the Test Scores

Validity of the scores obtained from the achievement test refers to degree of how much the scores really represent intended academic content. In other words, in order to obtain valid scores, the test items should cover all of the objectives in the curriculum. The most important evidence of content validity is the table of test specification which shows objectives and related test items together. For this study, content related evidence of validity is Table 3.3. As seen on this table, all of 16 objectives covered by test items.

3.6 Reliability of the Test Scores

Fraenkel and Wallen (1996) states that, in a research study, reliability refers to the consistency of scores measured by the instruments. This study focused on two types of it which are reliability through time (test-retest method) and internal consistency (Cronbach's Alpha method). As mentioned above, in this study, an achievement test was implemented two times as pretest and post-test. Reliability through time analysis was tested for the scores of these two implementations. Internal consistency which is related to average inter-item correlations was tested for the scores of posttest. Detailed explanations of reliability analysis performed in this study are available in the next chapter.

3.7 Settings and Conditions

The environmental conditions and physical settings should be clearly recorded in order to generalize the research results to similar populations. As mentioned in the previous sections, this study was performed in three public elementary schools in Yüzüncü Yıl district. This district is a rapidly developing region where various people live in modern residences and shanties together. This demographic variety is naturally represented in the schools as well. In other words, students from high and low socioeconomic families study in the same classrooms. Two of the chosen schools are very similar with respect to size, population, demographic characteristics and physical conditions. Both schools are small and uncrowded, and most of their students are from the families with low socioeconomic status. In addition, They both have limited educational opportunities with respect to lab equipments and internet access. However, the third school is a large and crowded one. In addition, most of its students are from the families with middle socioeconomic status. Also, this school has an active science lab with computer and internet access.

As mentioned in the previous sections, one science teacher from each three schools was chosen as the implementer. The first implementer was a 53 year old male teacher whose main profession is physics teaching. He graduated from a four year education institute and his teaching experience was 29 years. The second implementer was a 40 year old female teacher whose main profession is physics teaching. She graduated from a four year faculty of education and her teaching experience was 17 years. The third implementer was a 31 year old female teacher whose main profession is science teaching. She graduated from a four year faculty of education and her teaching experience was six years.

CHAPTER 4

RESULTS

As mentioned in the previous chapter, there were three main sources of data in this study: data from achievement test, data from balloon completing activity and open-ended questionnaires for students and teachers. In addition, there were supplementary data from background questions and treatment checklist. All of these data were analyzed, and the results were reported in following sections of this chapter. Raw data are available in Appendix L.

4.1 Descriptive Statistics of the Sample

Before reporting and discussing the descriptive statistics, it is appropriate to talk about the handling of missing data. There are two types of missing data in this study: missing students and missing items in the pretest and the posttest. There were no missing students in the pretest who took posttest. However, there were two missing students in the posttest who took pretest. These missing students were excluded from the data. There were many missing items in the pretest and the posttest. In the achievement questions, missing items were scored as zero. On the other hand, in the background questions and the attitude scale, missing items were scored as nine and assigned as missing in the statistical software. However, in the factor analysis, missing items in the background questions and attitude scale were replaced with mode of each item.

Data from background questions provide some descriptive information about

the sample. In this section, some important descriptive data are reported through tables. Table 4.1 shows the gender proportion in the sample.

Table 4.1 Gender Proportion in the Sample

	Frequency	Percent
Female	63	55.8
Male	50	44.2

As seen in the table above, the number of female students was obviously large. It was expected approximately equal numbers for gender proportion, there was no specific reason for this difference other than coincidence.

Table 4.2 shows father's education level of students. As seen in this table, almost half of the students have fathers with at least university degree. This is an evidence for quite high socioeconomic status in the sample.

Table 4.2 Father's Education Level

	Frequency	Percent
Primary School	12	10.6
Middle School	19	16.8
High School	25	22.1
University	45	39.8
Ms or Phd	9	8.0
Missing	3	2.7

Table 4.3 shows mother's education level of students. As seen in Table 4.3, almost half of the students have mothers with elementary school degree.

Table 4.3 Mother's Education Level

	Frequency	Percent
No School	6	5.3
Primary School	28	24.8
Middle School	20	17.7
High School	33	29.2
University	21	18.6
Ms or Phd	4	3.5
Missing	1	0.9

Table 4.4 shows the proportion of students' private room in which they can study without interruption. As seen in Table 4.4, most of the students have such a room which is another evidence for a quite high socioeconomic status.

Table 4.4 Student's Room at Home

	Frequency	Percent
No	25	22.1
Yes	88	77.9

Table 4.5 shows the proportion of students' computer at home which they can access easily whenever they need. As seen in Table 4.5, most of the students have a computer which is another evidence for a quite high socioeconomic

status. However, there is still a difference between the proportions of having room and computer.

Table 4.5 Student's Computer at Home

	Frequency	Percent
No	34	30.1
Yes	79	69.9

Table 4.6 shows the proportion of internet at home. As seen in Table 4.6, most of the students can access internet in their home which is another evidence for a quite high socioeconomic status. At first look, the comparison between the proportions of having computer and internet seems illogical. Actually, this means that some of the students do not have a computer which they can use easily whenever they need, however there is internet access in their home for other computers.

Table 4.6 Internet at Home

	Frequency	Percent
No	31	27.4
Yes	82	72.6

In general, these descriptive statistics demonstrate that the sample of this study has a relatively high socioeconomic status which is actually an expected situation. Because, Yüzüncü Yıl is known to be a district where mostly educated people with high income live.

In order to get deeper information about the sample, differences between subgroups in the sample should be explored. Table 4.7 demonstrates gender differences in the sample.

Table 4.7 Gender Differences in the Achievement

	Pretest						Posttest					
	Treatment			Control			Treatment			Control		
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD
Female	26	6.62	2.45	37	6.05	2.22	26	10.50	3.68	37	8.76	3.67
Male	26	6.08	1.85	24	6.38	2.26	26	10.27	3.54	24	8.96	3.46

As seen in the table above, any important difference between gender groups was not observed in the pretest or the posttest and in the treatment or the control groups.

As mentioned in the previous chapter, the pretest and the posttest included some attitude items adapted from TIMSS about students' enjoyment of science and their perception of success in science. Table 4.8 summarizes the results of attitude items.

As seen in Table 4.8, the most of the students seem to have extremely positive attitude toward science in both the pretest and the posttest. In addition, it was observed that the results of items about students' perception of success were

clearly lower than that of enjoyment items. However, these descriptive observations needs further analysis for deeper inferences.

Table 4.8 The Results of Attitude Items

	Frequency						Percent					
	SD	D	N	A	SA	M	SD	D	N	A	SA	M
Pretest Items:												
I like science topics	4	2	5	27	75	-	3.5	1.8	4.4	23.9	66.4	-
I enjoy reading science books	3	7	17	30	56	-	2.7	6.2	15.0	26.5	49.6	-
I enjoy reading science magazines	2	4	12	24	71	-	1.8	3.5	10.6	21.2	62.8	-
I enjoy watching science documentaries on TV	3	10	13	25	62	-	2.7	8.8	11.5	22.1	54.9	-
I like what I have learn in science lessons	2	-	7	34	70	-	1.8	-	6.2	30.1	61.9	-
I think I am talented in science	4	1	19	56	32	1	3,5	0.9	16,8	49,6	28,3	0.9
I think science lesson is easy	1	4	24	45	39	-	0.9	3.5	21.2	39.8	34.5	-
I have difficulties understanding science topics (reversely coded)	3	3	22	47	37	1	2.7	2.7	19.5	41.6	32.7	0.9
I think I am successful in science lesson	1	4	19	58	30	1	0.9	3.5	16.8	51.3	26.5	0.9
Posttest Items:												
I like science topics	3	-	7	23	80	-	2.7	-	6.2	20.4	70.8	-
I enjoy reading science books	3	6	17	27	60	-	2.7	5.3	15.0	23.9	53.1	-
I enjoy reading science magazines	1	5	10	23	74	-	0.9	4.4	8.8	20.4	65.5	-
I enjoy watching science documentaries on TV	3	8	13	27	67	-	2.7	7.1	11.5	19.5	59.3	-
I like what I have learn in science lessons	2	-	5	31	75	-	1.8	-	4.4	27.4	66.4	-
I think I am talented in science	3	-	18	54	36	2	2.7	-	15.9	47.8	31.9	1.8
I think science lesson is easy	1	1	26	44	41	-	0.9	0.9	23.0	38.9	36.3	-
I have difficulties understanding science topics (reversely coded)	1	3	20	44	42	3	0.9	2.7	17.7	38.9	37.2	2.7
I think I am successful in science lesson	1	1	21	55	35	-	0.9	0.9	18.6	48.7	31.0	-

After examining descriptive statistics about background questions and exploring gender differences, a factor analysis may be conducted in order to form new latent variables. The results of factor analysis can also be used for a validity evidence. Because, if a meaningful grouping in the background items is observed in the factor analysis, this is a clear sign of that students carefully read and answered the questions comprehending their meanings. Before conducting the factor analysis, it should be checked that data is appropriate for the factor analysis. There are three evidences about the appropriateness of data for the factor analysis: correlation matrix, KMO measure of sample adequacy, and Barlett's Test of Sphericity. Table 4.9 shows correlation matrix of background questions.

Table 4.9 Correlation Matrix of Background Questions

	Mother's Education Level	I have a room at home	I have a computer	I have internet at home
Father's Education Level	0.651	0.489	0.219	0.302
Mother's Education Level		0.310	0.007	0.266
I have a room at home			0.394	0.485
I have a computer				0.548

As seen in Table 4.9, the correlation values are generally above 0.3. To check the other two evidences, Table 4.10 shows KMO and Barlett's Tests.

Table 4.10 KMO and Barlett Tests

KMO Measure of Sampling Adequacy	0.632
Barlett's Test of Sphericity;	
Approx. Chi Square	172.385
df	10
Sig.	0.000

As seen in Table 4.10, KMO measure is above 0.6, and Barlett's Test is significant, therefore factor analysis can be conducted on these items. The results of factor analysis of background questions yielded two factors whose eigenvalues are above 1. In addition, these two factors explained 74.603 percent of the total variance. Table 4.11 shows the rotated component matrix of background questions where the extraction method is Principal Component Analysis and the rotation method is Varimax with Kaiser Normalization.

Table 4.11 Rotated Component Matrix of Background Questions

Items	Components	
	1	2
I have a computer	0.880	-0.067
I have internet at home	0.813	0.216
I have a room at home	0.638	0.460
Mother's Education Level	0.009	0.908
Father's Education Level	0.241	0.862

As seen in Table 4.11, the first component can be named as Home Resources (HOMER) and the second component can be named as Parents' Education Level (PARED).

Another factor analysis was conducted on attitude items in the pretest. Firstly, correlation matrix shows moderate correlations between attitude items. In addition, KMO measure is 0.795 and Barlett's Test is significant. Therefore, factor analysis is appropriate for these items. Factor analysis yielded two components whose eigenvalues are above 1. These two components explain 61.497 percent of the total variance. Table 4.12 demonstrates the rotated component matrix of attitude items in the pretest where the extraction method is Principal Component Analysis and the rotation method is Varimax with Kaiser Normalization.

Table 4.12 Rotated Component Matrix of Attitude Items in the Pretest

Items	Components	
	1	2
I have difficulties in understanding science topics (reversely coded)	0.849	0.200
I think science lesson is easy	0.847	0.166
I think I am successful in science lesson	0.716	0.101
I think I am talented in science	0.693	0.289
I like science topics	0.554	0.492
I enjoy reading science book other than textbook	0.054	0.872
I enjoy reading science magazines	0.173	0.825
I enjoy watching science documentaries on TV	0.385	0.536
I like what I have learned in science lesson	0.471	0.512

As seen in the table above, after examining the meanings of items, the first component can be named as “Students' Pre Perception of Success in Science” (PRESUCC). The second component can be named as “Students' Pre Enjoyment of Science”(PREENJY). The item about liking science topics seems

to be loaded closely in both components, however the meaning of this item is related to the second component. Therefore, in the table, it is shown in the second component. The term “pre” is used for naming these components, because, the items forming these components are from pretest which is implemented prior to the treatment.

Similarly, another factor analysis was conducted on attitute items in the posttest. Firstly, correlation matrix shows moderate correlations between attitude items. In addition, KMO measure is 0.803 and Barlett's Test is significant. Therefore, factor analysis is appropriate for these items. Factor analysis yielded two components whose eigenvalues are above 1. These two components explain 59.931 percent of the total variance. Table 4.13 demonstrates the rotated component matrix of attitude items in the posttest where the extraction method is Principal Component Analysis and the rotation method is Varimax with Kaiser Normalization.

Table 4.13 Rotated Component Matrix of Attitude Items in the Posttest

Items	Components	
	1	2
I have difficulties in understanding science topics (converted)	0.837	0.140
I think science lesson is easy	0.832	0.133
I think I am successful in science lesson	0.703	0.167
I think I am talented in science	0.665	0.274
I like what I have learned in science lesson	0.508	0.460
I enjoy reading science book other than textbook	0.037	0.877
I enjoy reading science magazines	0.208	0.812
I like science topics	0.540	0.550
I enjoy watching science documentaries on TV	0.401	0.479

As seen in Table 4.13, after examining the meanings of items, the first component can be named as “Students' Post Perception of Success in Science” (POSTSUCC) although it includes one item about enjoyment. The second component can be named as “Students' Post Enjoyment of Science” (POSTENJY). The item about learning in the science lesson seems to be loaded closely in both components, however the meaning of this item is related to the second component. Therefore, in the table, it is shown in the second component.

Data from achievement test were mainstream data of this study. Firstly, the achievement test was scored out of 17 where each correct item has one point. If a student selected a wrong alternative in an item, he/she got zero point for that item. Similarly, if a student missed an item, he/she got zero point as well. However, the data were examined to check non-random missing items. For instance, consecutive missing items at the end of the test are actually an evidence for the lack of time. This type of missing items can not be considered as random missing. In the data, it was not observed this type of missing items. The descriptive statistics of the achievement test and attitude scale are shown in Table 4.14.

As seen in Table 4.14, there is a clear mean increase from the pretest to the posttest in the treatment group. However at this point, it is impossible to infer the size of this increase in the mean. In the table, scores of PREENJY, PRESUCC, POSTENJY, POSTSUCC, PARED and HOMER are generated by factor analysis with regression method. Therefore, minimum values of these scores are negative. For instance, for HOMER, negative numbers can be inferred as the lack or absence of home resources. For POSTENJY, negative numbers in the table can roughly be inferred as negative opinions about the enjoyment of science.

Table 4.14 Descriptive Statistics of the Variables

	Group	N	Min	Max	Mean	St. Dev.	Skewness	Kurtosis
PREACH	Treatment	52	2	11	6.35	2.17	0.026	-0.747
	Control	61	3	12	6.18	2.23	0.394	-0.378
POSTACH	Treatment	52	3	16	10.38	3.58	-0.178	-0.901
	Control	61	2	16	8.84	3.56	0.279	-0.689
PREENJY	Treatment	52	-2.85	1.31	0.28	0.83	-1.876	4.187
	Control	61	-2.70	1.04	-0.24	1.07	-0.697	-0.712
POSTENJY	Treatment	52	-2.98	1.05	0.27	0.84	-2.187	5.351
	Control	61	-2.63	1.04	-0.23	1.07	-0.712	-0.695
PRESUCC	Treatment	52	-3.20	2.24	-0.08	0.97	-0.671	1.369
	Control	61	-3.47	1.77	0.07	1.03	-1.361	2.600
POSTSUCC	Treatment	52	-2.98	2.19	-0.05	0.94	-0.486	0.804
	Control	61	-3.83	1.79	0.04	1.06	-1.306	2.707
HOMER	Treatment	52	-2.30	1.03	-0.14	1.08	-0.758	-1.064
	Control	61	-2.30	1.03	0.12	0.92	-1.297	0.686
PARED	Treatment	52	-2.00	1.91	0.20	0.91	-0.453	-0.498
	Control	61	-2.43	1.79	-0.17	1.05	-0.322	-0.558

In addition, when skewness and kurtosis values are examined, it is observed that the distribution is approximately normal for achievement, home resources and parents' education level in both pretest and posttest. However, the distribution can not be accepted as normal for enjoyment and perception of success scores.

4.2 MANCOVA Results

As the mainstream analysis, data from the achievement test were analyzed through MANCOVA. As mentioned in the previous chapter, one of the dependent variable of this study is POSTACH which is in interval scale. The other dependent variables are POSTENJY and POSTSUCC which are formed

in the factor analysis. The independent variable of this study is TRE which is in nominal scale. In addition, the covariates of this study are PREACH which is in interval scale, PREENJY, PRESUCC, PARED and HOMER which are formed in the factor analysis.

To perform MANCOVA, Pallant (2005) states that a number of assumptions should be met which are listed below.

1. Dependent variable should be measured at ratio or interval scale.

2. The sample should be selected through random sampling.

3. The individual measurements of subjects should be independent.

4. The distribution of the scores should be normal.

5. The homogeneity of variances of the groups should be equal.

6. It should be ensured that the covariate is measured before the treatment.

7. The measure of covariate should be reliable.

8. The relationship between dependent variable and covariate should be linear.

9. Covariates should not strongly correlated.

10. Homogeneity in Regression Slopes should be observed.

11. Number of subjects in each cell (group) should be greater than 3.

12. The relationship between dependent variables should be linear.

13. Dependent variables should be moderately correlated.

14. Multivariate Normality should be met.

15. Homogeneity of variance-covariance matrices should be observed.

POSTACH is the posttest scores of science items which is measured in interval scale. On the other hand, POSTENJY and POSTSUCC are latent variables formed in the factor analysis. Therefore, the first assumption is met. On the other hand, the sample was not selected through random sampling. Therefore, the second assumption is not confirmed. In addition, data collection process was performed in a controlled environment in which teachers and the researcher were observers in the classrooms. Although some students tried to cheat, it can be accepted that individual scores were independent. Therefore third assumption is confirmed.

The distribution shape of scores was tested through the consideration of skewness and kurtosis values which are shown in Table 4.14. As seen in Table 4.14, the distributions of POSTACH, PREACH, HOMER and PARED scores in the dependent variables were found normal. However, the distributions of POSTSUCC, PRESUCC, POSTENJY and PREENJY scores were not found normal. Therefore, the fourth assumption is not met. However, Pallant (2005) states that multivariate analysis of variance is quite robust to modest violations of univariate normality.

All of the covariates were measured before dependent variables. Therefore, sixth assumption is met. In addition, the reliability of covariates which are generated from factor analysis are accepted as high. Also, the reliability of PREACH which is not generated from factor analysis is low where alpha is about 0.3. Actually, low reliability value of pretest scores are normal, because, pretest was implemented before the chapter. Students completed most of the

items without academic knowledge of the chapter. Therefore, PREACH is not excluded from the analysis and 7th assumption is considered to be confirmed.

Bivariate correlations among covariates were calculated. Table 4.15 shows correlation matrix of covariates. As seen in this table, there is no high correlations among covariates. Therefore, 9th assumption is confirmed.

Table 4.15 Correlation Matrix of Covariates

	HOMER	PARED	PRESUCC	PREENJY
PREACH	0.203	0.083	0.192	0.028
HOMER		0.000	0.333	0.095
PARED			-0.021	-0.009
PRESUCC				0.000

The shapes of relationships between dependent variables and covariates, and the relationships among covariates were examined through scatterplots. Figure 4.1 and Figure 4.2 show scatterplots for treatment and control groups, respectively.

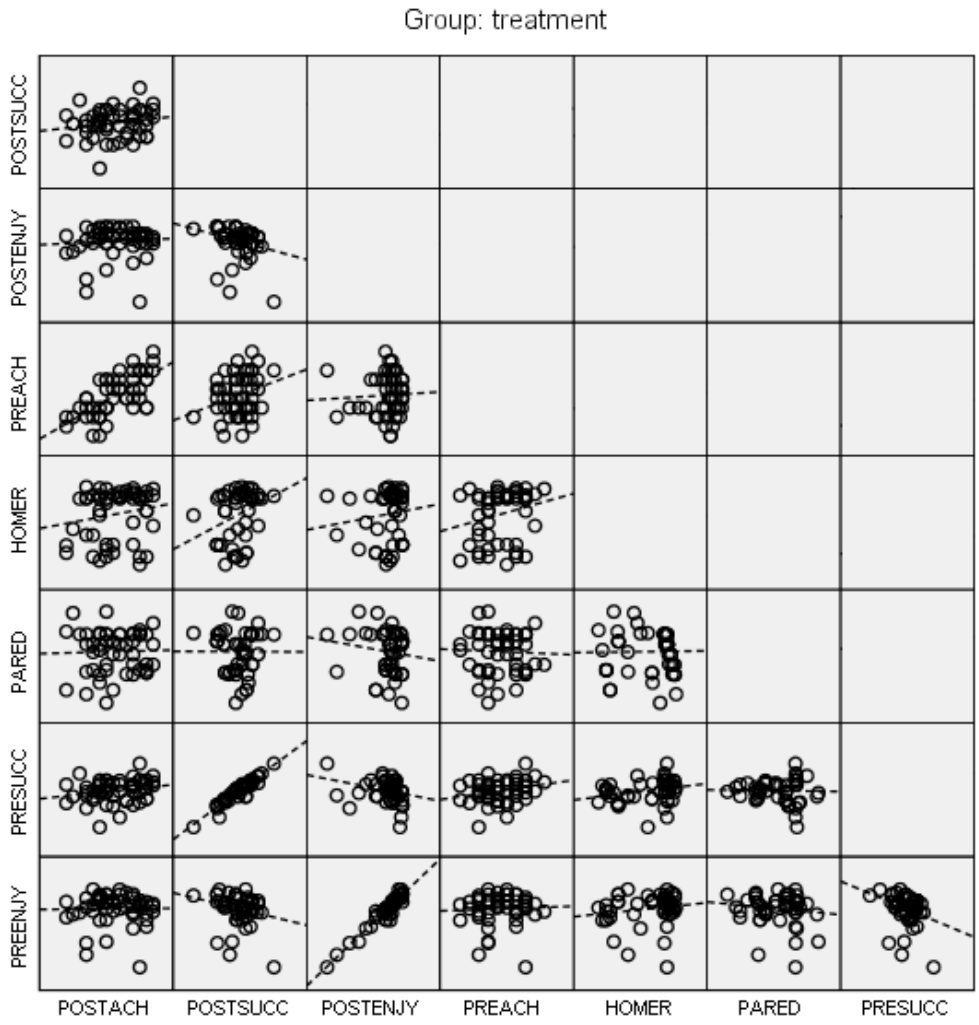

Figure 4.1 Scatterplots for the Treatment Group

As seen in Figure 4.1, any curvilinear relationships between the dependent variables and the covariates, and also among the covariates were not observed in the treatment group.

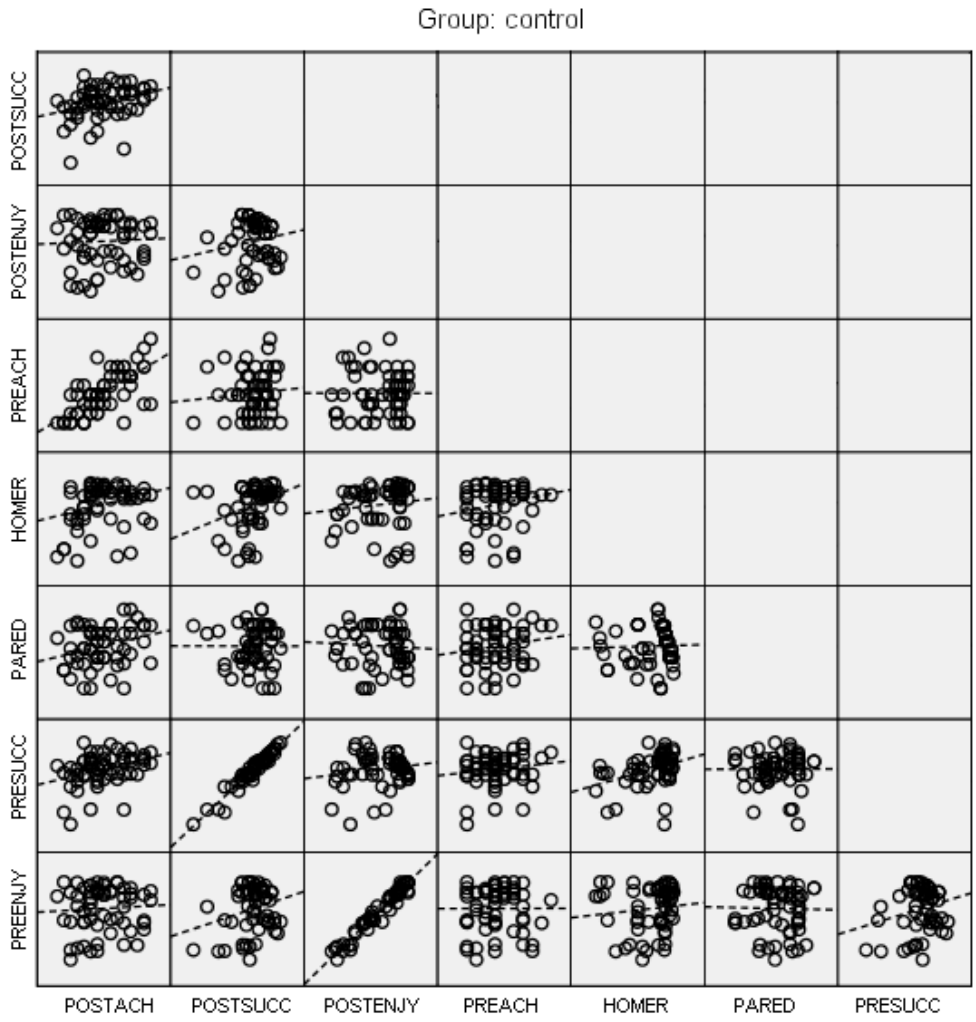

Figure 4.2 Scatterplots for the Control Group.

Similarly, as seen in Figure 4.2, any curvilinear relationships between the dependent variables and the covariates, and also among the covariates are not observed in the control group. Therefore, linearity assumptions (8^{th} and 12^{th}) are confirmed.

Pallant (2005) stated that the assumption of homogeneity of regression slopes is tested through the examination of interactions between the independent

variable and the covariates. In other words, regression lines should be similar between two groups. As seen in Figure 4.1 and Figure 4.2, it is not observed any significant interactions between POSTACH and covariates. Therefore, 10th assumption is met.

The 13th assumption which is about multicolinearity is checked through bivariate correlations among dependent variables. Pallant (2005) states that multivariate analysis of variance works best when the dependent variables are moderately correlated. It is not observed moderate correlations among dependent variables where the correlation between POSTACH and POSTSUCC is 0.239, between POSTACH and POSTENJY is 0.107, between POSTSUCC and POSTENJY is zero. This assumption is confirmed because it was not observed high correlations among dependent variables.

The assumption about multivariate normality is examined through Mahalonobis Distances. To ensure multivariate normality, Mahalonobis Distances of each subject should not exceed the critical value which is 16.27 for three dependent variables. When the sample is examined individually, it is observed that only one student exceed this critical value. Therefore, 14th assumption is confirmed.

In order to check equal variances assumption, Levene's Test were used. The result of Levene's Test of Equality of Error Variances is shown in Table 4.16.

Table 4.16 Levene's Test of Equality of Error Variances

	F	df1	df2	Sig.
POSTACH	2.222	1	111	0.139
POSTSUCC	0.085	1	111	0.771
POSTENJY	0.040	1	111	0.842

In the Levene's Test, the null hypothesis is that the error variance of the dependent variable is equal across groups. As seen in Table 4.16., the null hypotheses for each dependent variable are failed to reject. In other words, error variances of treatment and control groups can be regarded as equal for each dependent variable. Therefore 5th assumption is confirmed.

Finally, to check the assumption about homogeneity of variance-covariance matrices, Box's M test is used. In this test, the null hypothesis is that the observed covariance matrices of the dependent variables are equal. Table 4.17 shows the results of Box's M test. As seen in this table, the null hypothesis is failed to reject. Therefore, the last assumption is met.

Table 4.17 The Results of Box's M Test

Box M	F	df1	df2	Sig.
9.847	1.593	6	83332	0.145

After confirming the assumptions, MANCOVA was performed whose results are demonstrated in Table 4.18. In the MANCOVA, the first null hypothesis is that there is not a significant difference between the treatment and control groups on the linear combination of POSTACH, POSTENJY and POSTSUCC when effects of PREACH, PARED, HOMER, PREENJY and PRESUCC are controlled. As seen in Table 4.18, the null hypothesis is failed rejected where alpha is 0.05.

Table 4.18 MANCOVA Results

	Wilk's Lambda	F	Hypo. df	Error df	Sig.	Partial Eta Squared	Noncent Parameter	Observed Power
Intercept	0.846	6.327	3	104	0.001	0.154	18.982	0.962
PREACH	0.561	27.100	3	104	0.000	0.439	81.300	1.000
HOMER	0.995	0.178	3	104	0.911	0.005	0.534	0.082
PARED	0.938	2.298	3	104	0.082	0.062	6.893	0.565
PRESUCC	0.052	630.981	3	104	0.000	0.948	1892.942	1.000
PREENJY	0.031	1075.413	3	104	0.000	0.969	3226.240	1.000
TRE	0.943	2.102	3	104	0.104	0.057	6.307	0.524

However, the effects of dependent variables were examined separately through ANCOVA to check experiment wise alpha level. Table 4.19 shows the results of ANCOVA.

Table 4.19 Results of ANCOVA

Dependent Variable	Type III Sum of Squares	df	F	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power
POSTACH	39.68	1	6.095	0.015	0.054	6.095	0.687
POSTSUCC	0.008	1	0.105	0.747	0.001	0.105	0.062
POSTENJY	0.000	1	0.004	0.950	0.000	0.004	0.050

In the ANCOVA, the second null hypothesis is that there is not a significant difference in POSTACH between the treatment and the control groups where the effects of PREACH, PARED, HOMER, PREENJY and PRESUCC are controlled. This hypothesis is rejected where p is equal to 0.015. The effect size of the difference between the groups is 0.054 which can be considered as low. The power of the analysis is 0.687 which can be considered as moderate.

The third null hypothesis is that there is not a significant difference in POSTENJY between the treatment and the control groups where the effects of PREACH, PARED, HOMER, PREENJY and PRESUCC are controlled. This hypothesis is failed to reject where p is equal to 0.747.

The fourth null hypothesis is that there is not a significant difference in POSTSUCC between the treatment and the control groups where the effects of PREACH, PARED, HOMER, PREENJY and PRESUCC are controlled. This hypothesis is also failed to reject where p is equal to 0.950.

4.3 Reliability

As mentioned in the previous chapter, in a research study, reliability refers to the consistency of scores measured by the instruments. In this study, there are two reliability evidences: reliability through time and internal consistency. The evidence of reliability through time was obtained from test-retest method. The evidence of internal consistency was obtained from Cronbach's Alpha method.

4.3.1 Reliability through Time

The evidence of reliability through time was obtained from test-retest method. In other words, this reliability evidence was the correlation between the scores of pretest and post-test. The Pearson correlation between the pretest and the posttest is 0.674. Therefore, the correlation between the scores of pretest and posttest can be considered as moderate. Therefore, in this study, there is a moderately strong evidence of reliability through time.

4.3.2 Internal Consistency

In this study, the evidence of internal consistency is obtained from Cronbach's Alpha Method. This reliability analysis yielded the alpha value of 0.760 which is a moderate value. Therefore, in this study, there is a moderately strong

evidence of internal consistency.

4.4 Results of Balloon Completing Activities

As mentioned in the previous chapter, each comic story contained blank balloons which students were asked to complete after reading. Most of the students completed these balloons correctly or partially correctly. However, some important wrong answers were observed. Table 4. 20 shows descriptive statistics of balloon completing activities.

Table 4.20 Descriptive Statistics of Balloon Completing Activities

Blank Balloons	Number of Students	Correct Answers		Wrong Answers		Missing Answers
		Freq.	Percent.	Freq.	Percent.	
First Episode	52	41	78.8	11	21.2	-
Second Episode	52	38	73.1	14	26.9	-
Third Episode	52	31	59.6	21	40.4	-
Fourth Episode	51	44	86.3	7	13.7	-
Fifth Episode	51	31	60.8	19	37.3	1
Sixth Episode	52	27	51.9	25	48.1	-

As seen in Table 4.20, students answered most correctly in the fourth episode which is related to heating through radiation. In addition, they responded most wrongly in the sixth episode which is related to thermoses.

Students' important wrong and partially correct responses in balloon completing activity are listed below. Numbers in the parenthesis represent the number of students who responded in that ways.

- When polluted water is boiled, bacteria and viruses disappear. (8)

- Heated particles at the near end of the needle move to the far end. Therefore, the far end of the needle is heated. (1)

- Far end of the needle is heated by collisions of the particles. (5)

- Radiator panel heats the room by evaporation. (1)

- Sun can not heat earth much, because some of sunlight obstructed by stars. (1)

- Moon heats Earth by radiation. (4)

As seen in the list above, one of the most important finding was that the amount of students believing that microorganisms in boiling water disappear or vanish is not negligible. Another similar finding was about the amount of the students believing that heat conduction in solid objects occurs by the collisions of atoms and molecules. Another important finding from balloon completing activity was that a few students confused Sun with Moon which is in the episode four. Actually, the source of this confusion was the stars in the space. However, this drawing of sun is a view from outside of atmosphere which can be easily understood by the outside view of the Earth. Nevertheless, a small satellite might be drawn in this panel in order to emphasize empty space between Sun and the Earth.

4.5 Results of Analysis of the Open-Ended Questionnaires

In this study, in addition to statistical results, there were some qualitative results obtained from open-ended questionnaires for teachers and students. The results of open-ended questionnaires for teachers and students summarized in

the following sections.

4.5.1 Results of the Open-Ended Questionnaire for Teachers

At the end of the treatment, an open- ended questionnaire with eight questions were given to three teachers. To see this questionnaire, check Appendix H. The responses of the teachers were summarized in Table 4.21. Numbers in the parenthesis show the frequency of the response.

As seen in Table 4.21, one of the most important finding from the open ended questionnaire for teachers is that teachers observed that comics definitely increase the participation of students, especially silent ones. Another important finding is that teachers thought that balloon completing activities provide more feedbacks about students' difficulties.

Table 4.21 Responses of Teachers in the Open-ended Questionnaire

Question	Selected Answers
What are the superior features of instructional comics activities than traditional ones?	> This activity is not tiring for teachers. (1) > Teachers observe more about difficulties of students. (2) > Instructional comics are good for quick evaluation during lessons. (1)
What changes did you observe in students' behaviors with respect to participation and discipline during the implementation of instructional comics?	> Silent students raised their hands frequently. (3) > Participation was definitely increased. (3) > Classroom management was easier. (3)
What changes did you observe in students' success during the implementation of instructional comics?	> Increase in success was not observable. (1)
Do you think instructional comics affect girls and boys equally?	> Usually, girls are not interested in science. However, an increase in participation of girls was observed during instructional comics. (2)

Table 4.21 Responses of Teachers in the Open-ended Questionnaire (Continued)

Question	Selected Answers
Do you think instructional comics affect successful and unsuccessful students equally?	> Unsuccessful students definitely participated more than usual. (2)
Do you think instructional comics affect students from high and low socio-economic families equally?	> No, comics were appropriate for all. (3)
What are disadvantages of instructional comics?	> Fast readers completed activity quickly and waited for discussion. (1)
How can instructional comics be made more effective?	> This activity may be combined with drama. (1)

4.5.2 Results of the Open-Ended Questionnaire for Students

At the end of the treatment, the open-ended questionnaire with five questions were given to 52 students in the treatment group. This open-ended questionnaire is available in Appendix I. The important answers of students which may have some implications to this study are summarized in Table 4.22. Numbers in the parenthesis demonstrate the frequency of the response.

As seen in Table 4.22, one of the most important results is that students demanded instructional comics in course books of not only science but also the other courses. Another important result is that students thought that comics are useful in long term learning. Another important results is that most of the students found comics funny or humorous.

Although they have low frequencies, the students reported three disadvantages of instructional comics. One students found instructional comics time wasting.

It should be noted that this student was the most hard-working student in his classroom. In addition, one student did not like reading comics. Another student thought that comics may ruin the discipline in the classroom.

Table 4.22 Important Answers of Students in the Open-ended Questionnaire

Question	Answers
Can instructional comics make instructional process funnier? Why?	> Yes, because children like comics. (4) > Yes, because comics are colorful.(2) > Yes, because comics are humorous. (6) > Yes, because comics are adventurous. (1) > Yes, because children like playing games. (1) > No, because comics prevent discipline in the classroom. (1)
Can instructional comics provide an effective learning? Why?	> Yes, because comics attract attention. (10) > Yes, because comics are funny. (23) > Yes, because comics create curiosity. (1) > Yes, because comics connect topics to real life.(2) > Yes, because comics are visual.(10) > No, because topics are discussed messy. (1)
What are the advantages of instructional comics?	> Children won't forget course topics. (14) > Children are eager to read comics. (7) > Comics make topics easier. (2) > Comics make children study willingly.(3) > Comics encourage children to read. (3) > Comics develop reading ability. (4) > Comics increase students' participation. (3) > Comics increase students' imagination. (2) > Comics make children learn quickly.(4) > Comics prevent memorizing.(1)
What are the disadvantages of instructional comics?	> Comics may be time-wasting. (1) > Some children may not like reading comics. (1) > Some students may be spoilt when reading comics. (1)
How can this instructional activity be made more effective?	> Comics can be computerized. (3) > Comics may be played as drama. (2) > Comics could be more humorous. (4) > Children can draw their own comics. (1) > There should be comics on course book. (3) > There should be more comics. (6) > There should be comics in other courses. (9)

4.6 Treatment Verification

As mentioned in the previous chapter, a treatment checklist were used to evaluate the treatment and data collection procedures by the researcher and the teachers. Table 4.23 summarizes the results of treatment verification. In the table, Res. is the abbreviation of researcher, T1, T2 and T3 represent the teachers. Numbers in the parenthesis represent total number of observations.

As seen in Table 4.23, the researcher observed 10 lessons in the treatment group in which totally 18 lessons were completed in three classrooms. In addition, the teachers evaluated all of their lessons. On the other hand, the researcher observed 10 lessons in the control group in which totally 24 lessons were completed in four classrooms. In addition, the teachers evaluated all of their lessons.

The items can be categorized in two groups: the items measuring the extraneous variables and the items measuring authenticity of the treatment. The items measuring extraneous variables include the first item and the last six items. The items measuring the authenticity of the treatment include all of the other items, respectively. In the first group, the items were coded reversely because their meanings are negative. For example, in the last item, the researcher have eight checks which does not mean that eight unintended events occurred. Before reverse coding, there were two checks in this cell which means two unintended events occurred in the observed 10 lessons.

Table 4.23 Frequencies in the Treatment Verification Checklist

Item	Treatment				Total	Control				Total
	Res. (10)	T1 (6)	T2 (6)	T3 (6)	28	Res. (10)	T1 (12)	T2 (6)	T3 (6)	34
Is there any significant student loss in the beginning of the lesson? (Reversely Coded)	10	6	6	6	28	10	12	6	6	34
In the beginning of the lesson, did at least one student summarize the comic of previous lesson?	10	6	6	6	28	0	0	0	0	0
Did all students read the comic of the lesson?	10	6	6	6	28	0	0	0	0	0
Were the students provided with enough time to read the comic?	10	6	6	6	28	0	0	0	0	0
After reading comics, did at least one student summarize the comic?	10	6	6	6	28	0	0	0	0	0
Did students complete empty fields in the comics?	10	6	6	6	28	0	0	0	0	0
Were the students provided with enough time to complete empty fields?	10	6	6	6	28	0	0	0	0	0
Did enough number of students state what they wrote in the empty fields?	10	6	6	6	28	0	0	0	0	0
Did the students explain the reason of their statements in the empty fields?	10	6	6	6	28	0	0	0	0	0
Did any discussions about the empty fields formed in the classroom ?	10	6	6	6	28	0	0	0	0	0
After discussion, did the teacher explain the correct statement for the empty fields?	10	6	6	6	28	0	0	0	0	0
Did the teacher explain the science concept in the comic briefly?	10	6	6	6	28	0	0	0	0	0
During the lesson, did any events which may prevent reading and understanding of comics occur? (Reversely Coded)	10	6	6	6	28	10	12	6	6	34
During the lesson, did the teacher implement any additional activities which do not exist in the lesson guide? (Reversely Coded)	10	6	6	6	28	10	12	6	6	34
Did the students think that they are in a competition with the other group? (Reversely Coded)	10	6	6	6	28	10	12	6	6	34
Did the students think that the other group is more advantageous? (Reversely Coded)	10	6	6	6	28	10	12	6	6	34
Did the teacher behave non-neutral in this group? (Reversely Coded)	10	6	6	6	28	10	12	6	6	34
During the lesson, did any events which may affect the duration of the lesson occur? (Reversely Coded)	8	5	6	5	24	10	11	6	6	33

In the authenticity group of items, most of the items were checked positively in the treatment group which means that the authentic treatment occurred as planned in the treatment group. In addition, the frequencies of the researcher's and the teachers' observations are consistent for the most of the items. In the control group, there were no checks as expected. On the other hand, in the extraneous variable group of items, some negative checks were observed in the last item which is about unintended events during the lesson. The researcher and the teachers reported two unintended events in the treatment group. One of them is a donation call and the other is the promotion of the mobile library which affect the duration of two lessons in the treatment group. Similarly, one of the teacher reported an unintended event in the control group which is the announcement of national holiday activities.

4.7 Summary of the Results

Data from background questions, attitude items, achievement items, open-ended questionnaires and treatment verification checklist were analyzed and the results were reported in this chapter.

One of the most important descriptive result is that almost half of the students have fathers with at least university degree. Another important descriptive result is that about 80 percent of the students have computer and internet access in their homes. These results are strong evidences for a high socioeconomic status in the sample.

One of the most important results of MANCOVA is that the instructional comics do not have any effects on the combination of students' post achievement in heat transfer, their post enjoyment of science and post perception of success in science where the effect of a set of extraneous variables are controlled. However, it was found a low effect of the instructional comics on students' post achievement in heat transfer where the effect of a set

of extraneous variables are controlled. The analysis of partially correct and wrong answers in the balloon completing activity yielded some important results. For instance, about 15 percent of the students thought that bacteria and viruses disappear when polluted water is boiled. In addition, about 10 percent of the students thought that heat is transferred by atomic or molecular collisions in the solid objects.

Open ended questionnaires provide some important information about the opinions of the students and the teachers about the instructional comics. For example, approximately half of the students thought that instructional comics are funny. In addition, about 30 percent of the students thought that instructional comics result in long term learning. Also, 20 percent of the students thought that comics can attract their attention. Similarly, all of the three teachers thought that students' participation is definitely increased and classroom management is very easy when instructional comics are implemented. Two of three teachers thought that instructional comics provide a better environment for the observation of students learning difficulties.

CHAPTER 5

DISCUSSION

In this chapter, issues in quantitative and qualitative results were discussed in detail. In addition, implications to related institutions and suggestions for further researches were reported in the following sections.

5.1 Issues in Quantitative Results

In the beginning of this study, it was hypothetically expected that students in the comics group would get higher achievement than the students in the control group at the end of matter and heat chapter. After data collection, statistical results supported this hypothesis. In other words, it can be speculated that instructional comics created more effective learning atmosphere in the classroom than the other common instructional approaches. However, the questions how and why have not answered yet. Actually, this is the subject of an independent qualitative research study. However, at this point, some speculative answers may be produced in the light of literature.

In this study, comics were clearly found to be an effective instructional activity. The reason for the effectiveness of instructional comics may be hidden in the structure of comics media. Comics are unique combination of storytelling and the art of drawing. Darvell (1997) stated that storytelling is so effective in teaching something that we never forget our childhood tales. On the other hand, drawings and illustrations are doubtlessly effective teaching

aids. One of the reasons for the effectiveness of instructional comics may be the perfect match of these two components.

Another powerful feature of instructional comics that make them very effective may be the necessity of unique reading style. Rota and Izquierdo (2003) stated that, unlike text-only stories, comics requires a special type of active reading. Actually, comics are periodically interrupted stories. In other words, there are gaps between panels, therefore the reader should actively think and guess about these gaps while reading. One of the reason for the effectiveness of instructional comics may be the necessity of such an active reading.

Comics generally tell about the adventures of possible real life characters. In other words, comics have natural connections to our daily lives. According to Witkowski (1997) comics have an important role in communicating science in public, because humorous daily life events in the comics makes science concepts simpler and more familiar. Therefore, another reason for the effectiveness of instructional comics may be their natural connection of real life.

In this study, it was statistically found that the instructional comics have no effects on students' post enjoyment of science and their post perception of success in science which is a hypothetically unexpected result. Actually, there is a potential reason for this unexpected result. In this study, it was observed that students' post enjoyment of science and their post perception of success was at nearly maximum in the pretest. Therefore, no increase in these two attitude variables was observed in the posttest.

5.2 Issues in Qualitative Results

As mentioned in the previous chapters, in this study, the qualitative results

were obtained from balloon completing activities and the open-ended questionnaires for students and teachers. In addition, the personal observations of the researcher were another qualitative data to be discussed in this section.

As mentioned in Chapter 4, students gave some important wrong responses in balloon completing activity and some of them might be directly because of comics. For example, in this study, four students from different classes wrongly stated that moon heats the earth. Because they thought the shiny object in the comic story should be the moon, because sun can not be seen at nights. In other words, they could not distinguish sun in space and moon at night. To avoid this misunderstanding, this panel may be drawn differently.

In balloon completing activity, five students in different classes wrongly stated that heat is transferred in metal needle by collisions. Clearly, for this students, comics were not useful for learning the difference between vibrations and collisions. Actually, as still papers, comics may not be sufficient to describe the types of movements which is one of the most important disadvantage of comics.

In balloon completing activity, most of the students stated that viruses and bacteria die in boiled water. However, eight students wrongly believed that viruses and bacteria disappear of totally vanish in boiled water. Actually, in the comic story, there were not any implication to think so.

As mentioned in the previous chapters, the researcher observed most of the lessons during treatment and teachers and students were asked to complete an open ended questionnaire after treatment. An important observation during study was that all of the teachers regarded instructional comics as supplementary activities in traditional expository teaching/learning approach. However, most of the students regarded comics as mainstream teaching/learning approach. In other words, students seem to be definitely more

open for radical changes in educational policies than teachers. This was a very striking observation of sharp difference in students' and teachers' mentality about instructional processes.

In this study, instructional comics were quantitatively found to be effective, and qualitatively observed that they make learning an entertaining activity. On the other hand, it was also observed that they doubtlessly have some positive side effects. The most important side effect of instructional comics may be about their relationship to reading activity. Most of the children do not like read text-only stories. However, in this study, it was clearly observed that students read comics so willingly that perfect silence occurred during reading session. It can be claimed that comics make children love reading and they develop children's reading ability in long term.

Another important positive side effect of instructional comics may be related to classroom management. In open-ended questionnaires, teachers expressed that they got tired much less in comics activities, because students were so busy with comics that teachers made less effort to manage classroom.

Probably, the most important qualitative finding of this study is that almost all of the students demanded comics in the course books, not only in the science and technology course, but also in the other courses. Such a clear request should have a meaning for formal education. Actually, this clear finding probably points the lack of humor and entertainment in formal education. And it was obviously observed that students definitely demand more humor and entertainment in the classroom.

5.3 External Validity

External validity is the degree of generalization of the results to target

population. There are two types of external validity; population validity and ecological validity.

Population validity is the degree of representation of selected sample to the population. In this study, in order to ensure population validity, the experiment was performed in a quite large sample which is approximately 40 percent of the size of the population. Table 3.1 can be accepted an evidence for the population validity.

Ecological Validity is the degree of generalization of the results to the other settings. Ecological validity can be ensured through detailed records about settings and environmental conditions during implementation and data collection so that another researcher can easily perform a duplicate study. For example, as mentioned in the previous sections, the accessible population of this study was all sixth graders from public schools in Yüzüncü Yıl district in Ankara. The results of this study can not be generalized to the private schools in that district, because it is known that the environmental conditions of private and public schools are clearly different. In addition, the results of this study can not be generalized to the students living in the rural areas, because, the environmental conditions in the rural schools are known to be quite different from Yüzüncü Yıl district. Therefore, the environmental conditions and settings should be clearly recorded in order to generalize the research results to similar populations. Environmental conditions and settings of the study are explained in Chapter 3.

5.4 Internal Validity

Internal validity indicates the degree of control of extraneous variables in the research process. Like all research studies, this study was open to internal validity threats. However, some control mechanisms were applied to prevent unintended extraneous variables as much as possible.

As mentioned in previous sections, in this study, intact classes were assigned as treatment or control groups. Therefore, these classes can not be claimed to be doubtlessly equivalent. So, subject characteristics was a possible threat for this study. To control the threat of subject characteristics, covariate analysis was used in order to filter extraneous variables. In addition, the research design used in this study controlled some aspects of this threat. For example, in each school, there were both treatment and control groups. Under normal conditions, this may help controlling subject characteristics partially. However, some school administrations form classrooms according to the prior success of students which may clearly have an effect on the results.

In schools, some students have extra activities in school days, such as, turn of duty, practice in sport team and preparations to national holidays. This causes a subject loss in pretest or posttest, which is called mortality. In this study, almost all of the students in pretest completed posttest. Only two students were missing in the posttest who were excluded from the analysis. In addition, there were no new students in the posttest who did not take pretest. Therefore, mortality was not a real threat for this study.

Some special events affect classroom atmosphere negatively, such as national football matches or vaccine days. Such events may change the results of research, which is called history threat. In this study, no important events happened during data collection and treatment. In addition, teachers were not reported any unintended situation in their treatment checklists. Therefore, it can be said that history was not a threat for this study.

The reason of the mean difference between the treatment and the control groups may be only novelty of the treatment, which is called Hawthorn Effect. To prevent this, a placebo treatment can be implemented in control group. Actually, it is hard to prepare a placebo treatment which is really ineffective. In this study, there was no real placebo in control group. Hawthorn Effect may be

valid for this study. The lack of placebo was one the weaknesses of this study.

Sometimes control group is demoralized due to new treatment applied in experimental group. Or sometimes control group compete with the experimental group which is called John Henry Effect. To identify and prevent these two threats, the teachers should observe the behaviors of students. If there are some signs for these two threats, the teachers should inform students about that all activities in treatment and control groups are regular parts of instruction. Therefore, in this study, teacher were informed about these threats and possible remedies. In addition, teachers did not reported any unintended students' behavior in treatment checklist. However, it is still hard to say that there was no demoralization in the control group or competition between two groups in this study.

In general, the analysis of treatment checklist filled by the researcher and teachers showed that treatment of this study were implemented in its authentic form and data collection was done in a fair atmosphere.

5.5 Implications

The results of this study have some important implications to the educational institutions. One of these implications is to Ministry of National Education. Comics are effective, inexpensive and technology independent instructional materials. In addition, in this study, students demanded instructional comics in all courses which possibly mean that students want more entertaining atmosphere in their classrooms. Instructional comics can be integrated in curricula of several courses. Also, an online comic library which is accessible to students and teachers can be established, or a series of comic books can be distributed to public schools. In short, the Ministry of National Education can encourage the use of instructional comics in teaching/learning process.

As well as Ministry of Education, Ministry of Health can also use comics to inform adults about contagious diseases, such as AIDS and jaundice. In addition, vaccine campaigns can be announced by comics effectively. Also, children can be learn basic hygiene and body care by reading instructional comics.

The other implication of the results of this study is to faculties of education. In this study, instructional comics were found to increase the participation of reluctant students. This feature of comics has an implication about handling problematic students and classroom management. Also, it was observed that comics increased students' willingness in reading. This aspect of comics should have an implication to the courses including plenty of reading, such as literature and history. Faculties of education can encourage the use of comics as instructional material by prospective teachers.

It is clear that the unique mission of faculties of education is not training teachers. The other mission is doing researches to develop new instructional approaches. In the cooperation with publication industry, faculties of education should produce instructional comics about variety of topics of school courses.

In our country, there are some social foundations focusing on children and education, such as Turkish Education Foundation and Turkish Education Volunteers. These foundations easily reach economically disadvantaged children. Therefore, comics are very appropriate instructional tool for these foundations.

One of the most important issues in the education is providing better learning opportunities for impaired students. Traditional school instruction is mainly based on teachers' exposition. In addition, the most of the modern instructional approaches emphasize the use of multiple senses in the instructional process. This makes traditional and modern approaches not useful for impaired

students. On the other hand, because of their visual only nature, the instructional comics are especially useful for hearing impaired students. Therefore, this study has also an implication for the Ministry of National Education in the education of hearing impaired students.

The purpose of popular science magazines is to inform people about developments in science and technology in an easy and attractive way. Comics are naturally suitable and useful for this purpose. Therefore, popular science magazines can publish educational comics to attract attention and to simplify the complex science and technology concepts.

Another implication of instructional comics is to UNESCO and UNICEF. As mentioned above, comics are effective, inexpensive and technology independent instructional materials. Therefore, these international institutions can provide educational comic books for children with limited opportunities.

5.6 Suggestions for Further Research

This study naturally had some limitations and weaknesses. One these weaknesses was the lack of retention test. In the original design of this study, there was the implementation of retention test. However, in all chosen schools, matter and heat chapter was delayed due to students' projects in the previous chapters. Thus, there was no enough time space between posttest and retention test. Researchers who are interested in instructional comics should include retention test in their research design. Because, it is probably hard to forget the adventures of comic heroes.

Instructional comics used in this study were about the course of science and technology. Actually, comics can easily be integrated to the other courses. As mentioned in the previous section, comics are especially appropriate for the courses needing plenty of reading, such as literature, history and foreign

language courses. Because, children like reading comics. Therefore, researchers from other fields should examine the effectiveness of instructional comics in their fields.

As mentioned above, a few students responded wrongly in balloon completing activity, probably because of drawing styles of some panels of comics. Therefore, researchers can remember that panels should be so clear that students do not misunderstand anything.

In some aspects, comics are similar to animated cartoons in television. Both contain adventures of heroes and both are colorful and humorous. However, unlike comics, cartoon animations are dynamic. On the other hand, unlike cartoon animations, comics are easier to construct and much more cheaper. A comparison of comics and cartoon animations would be a very interesting research.

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APPENDIX A

INITIAL FORMS OF INSTRUCTIONAL COMICS USED IN THIS STUDY

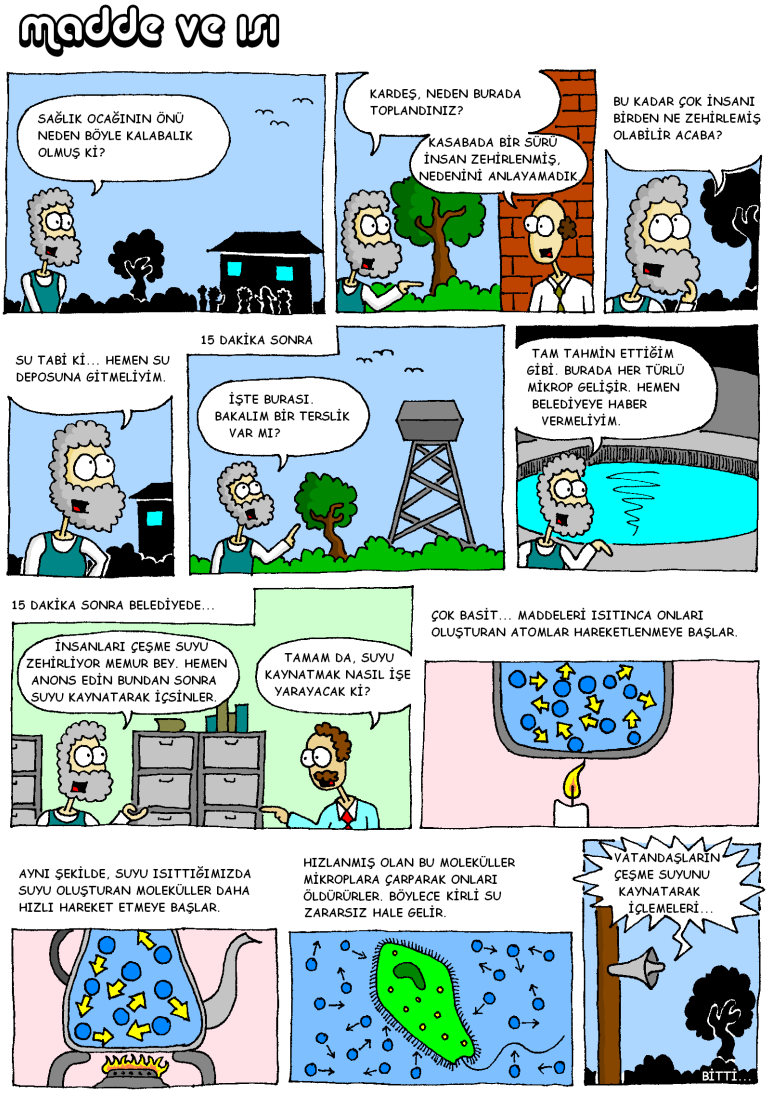

Figure A.1 Initial Comic Story about Mater and Heat

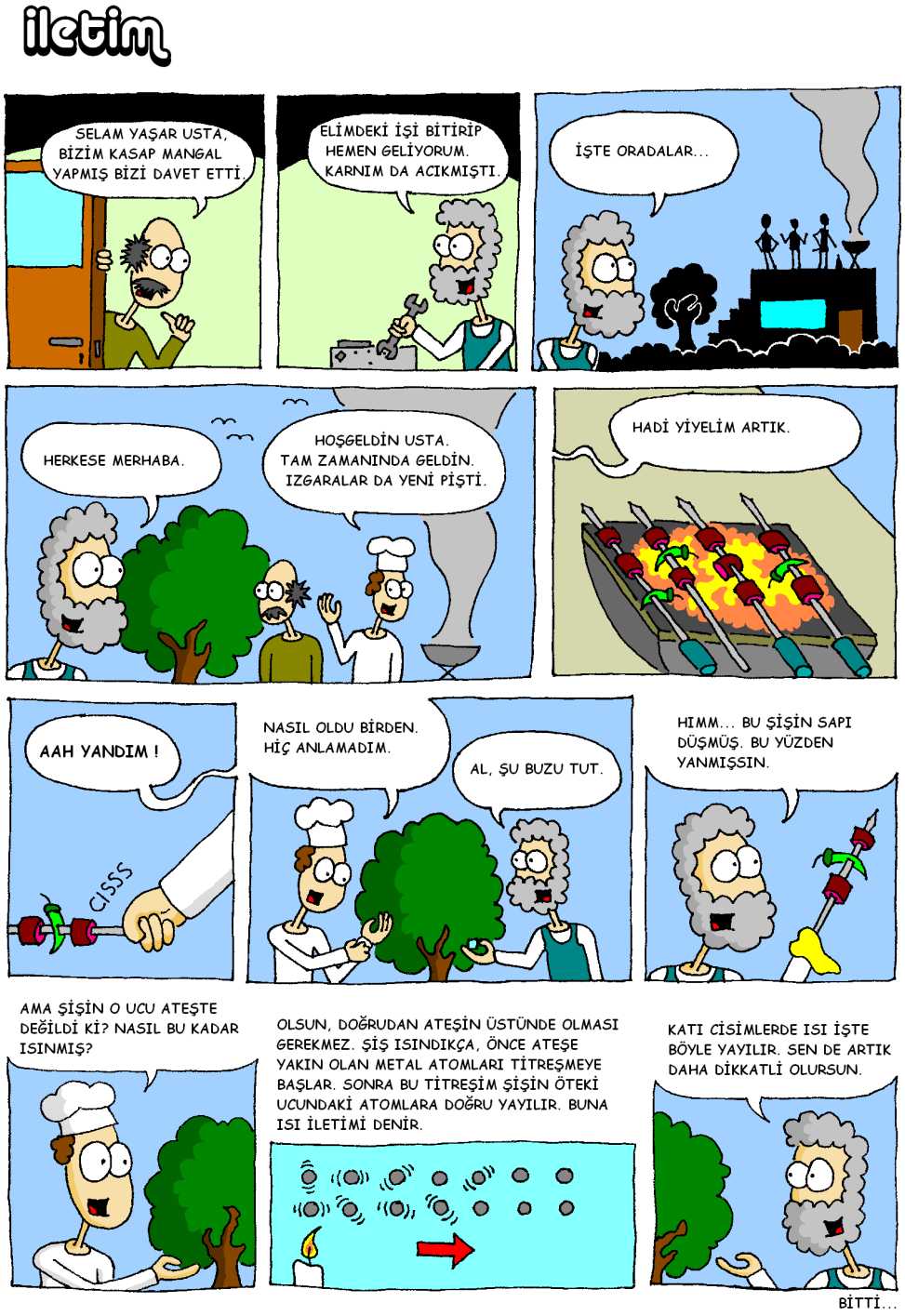

Figure A.2 Initial Comic Story about Heat Conduction

Figure A.3 Initial Comic Story about Convection

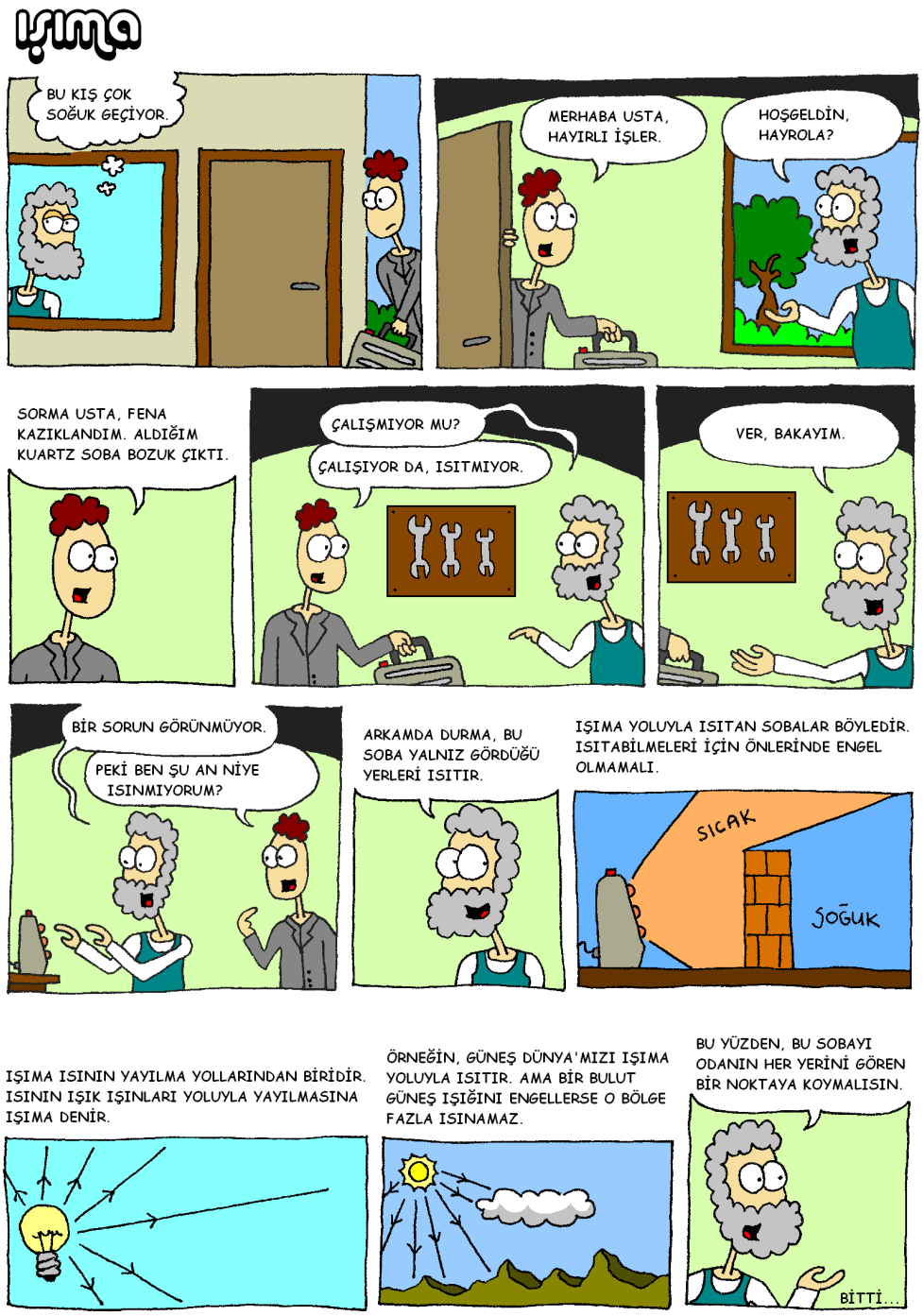

Figure A.4 Initial Comic Story about Radiation

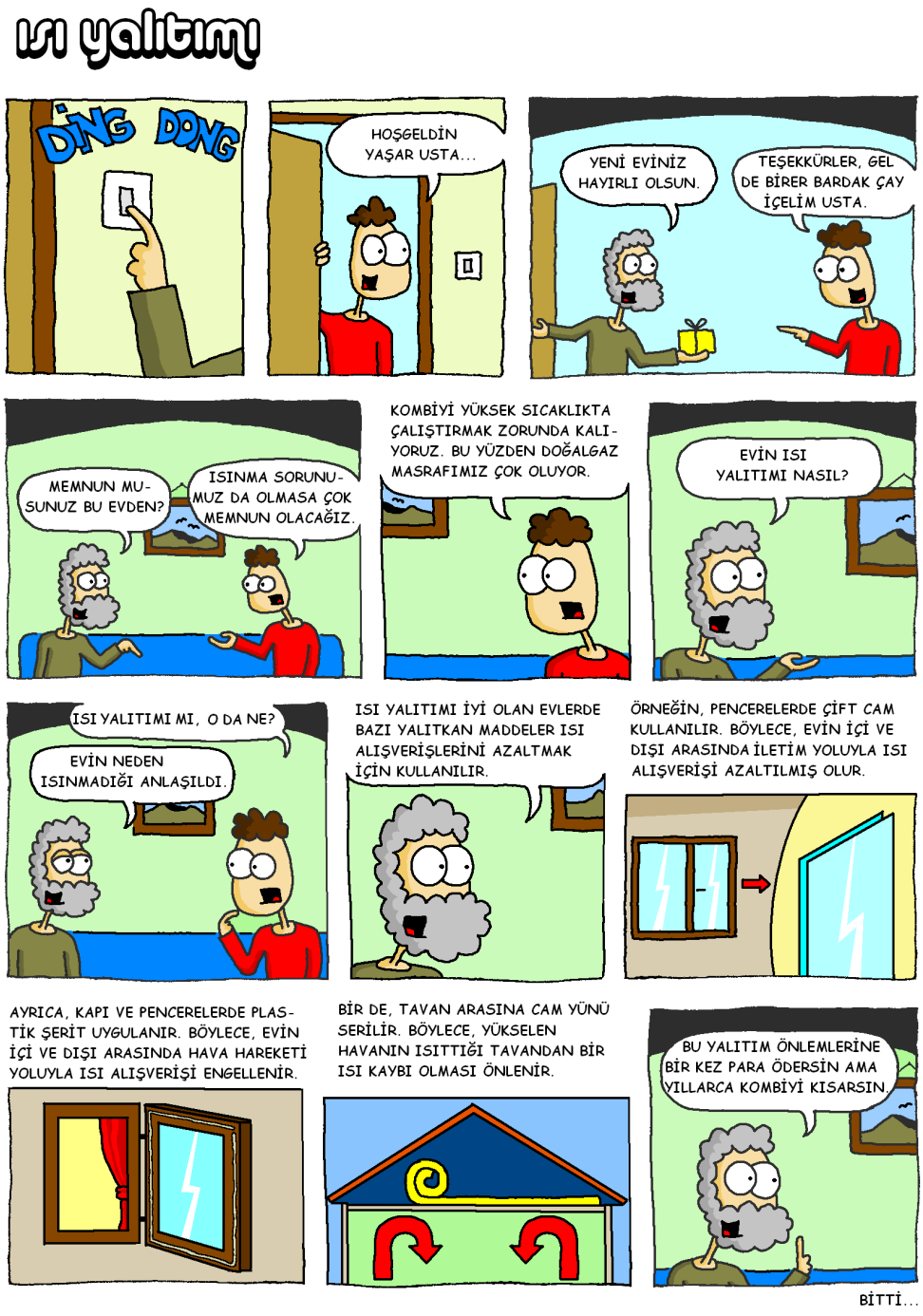

Figure A.5 Initial Comic Story about Heat Insulation

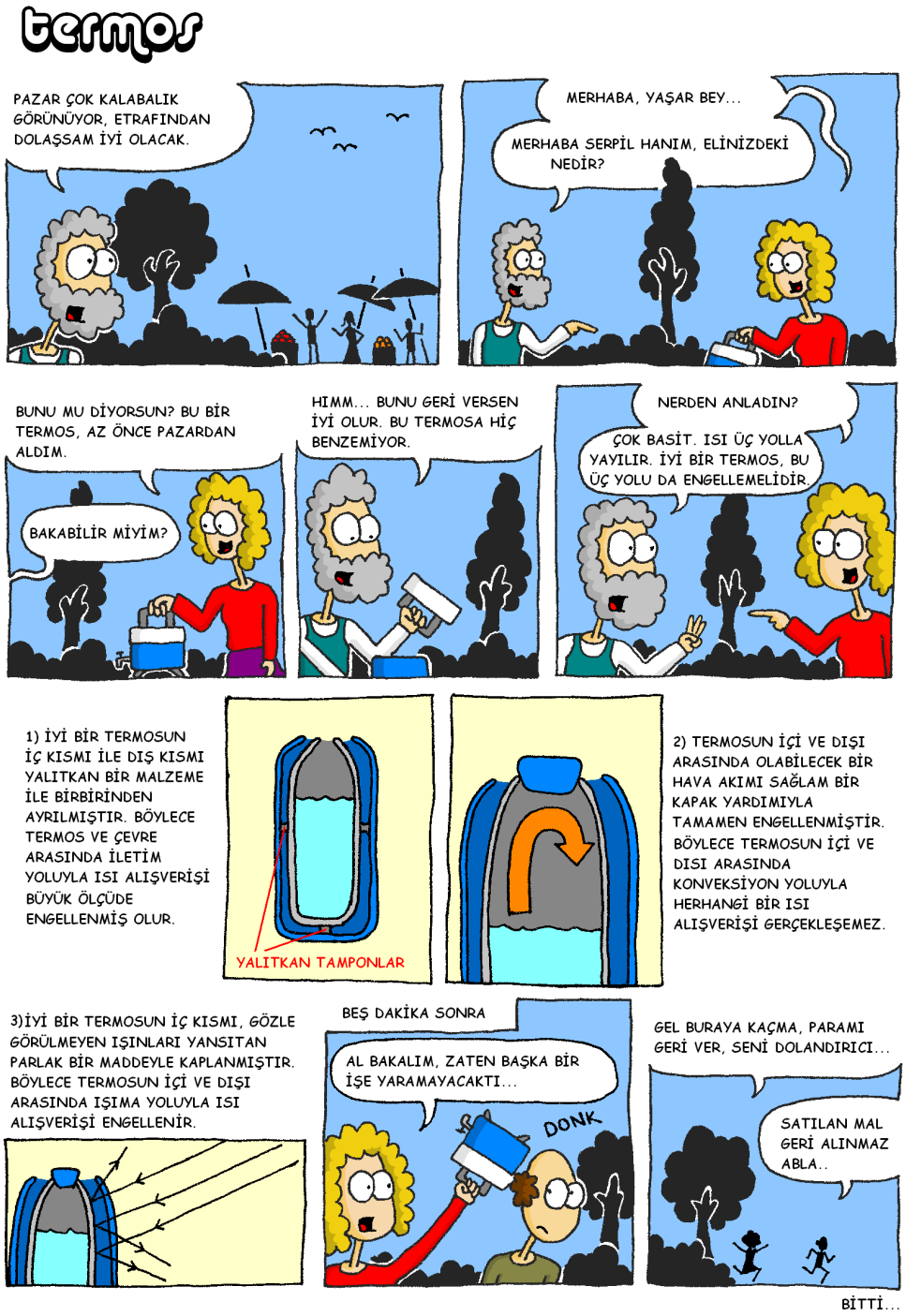

Figure A.6 Initial Comic Story about Thermoses

APPENDIX B

FINAL FORMS OF INSTRUCTIONAL COMICS USED IN THIS STUDY

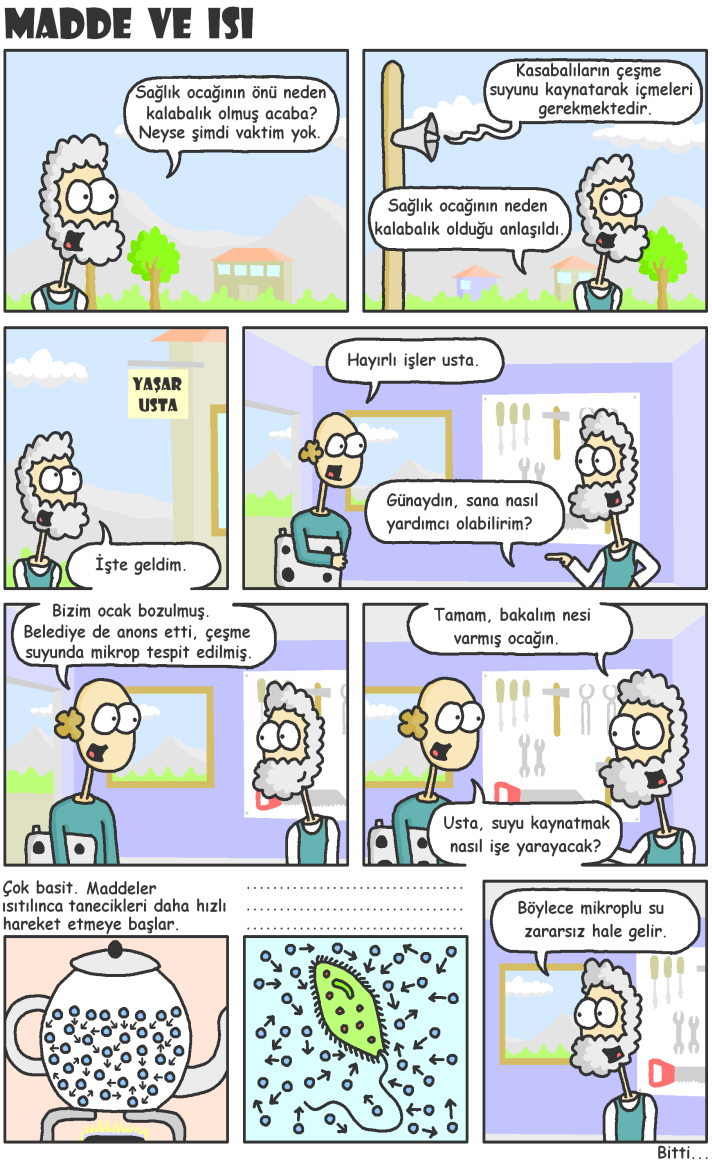

Figure B.1 Final Comic Story about Matter and Heat

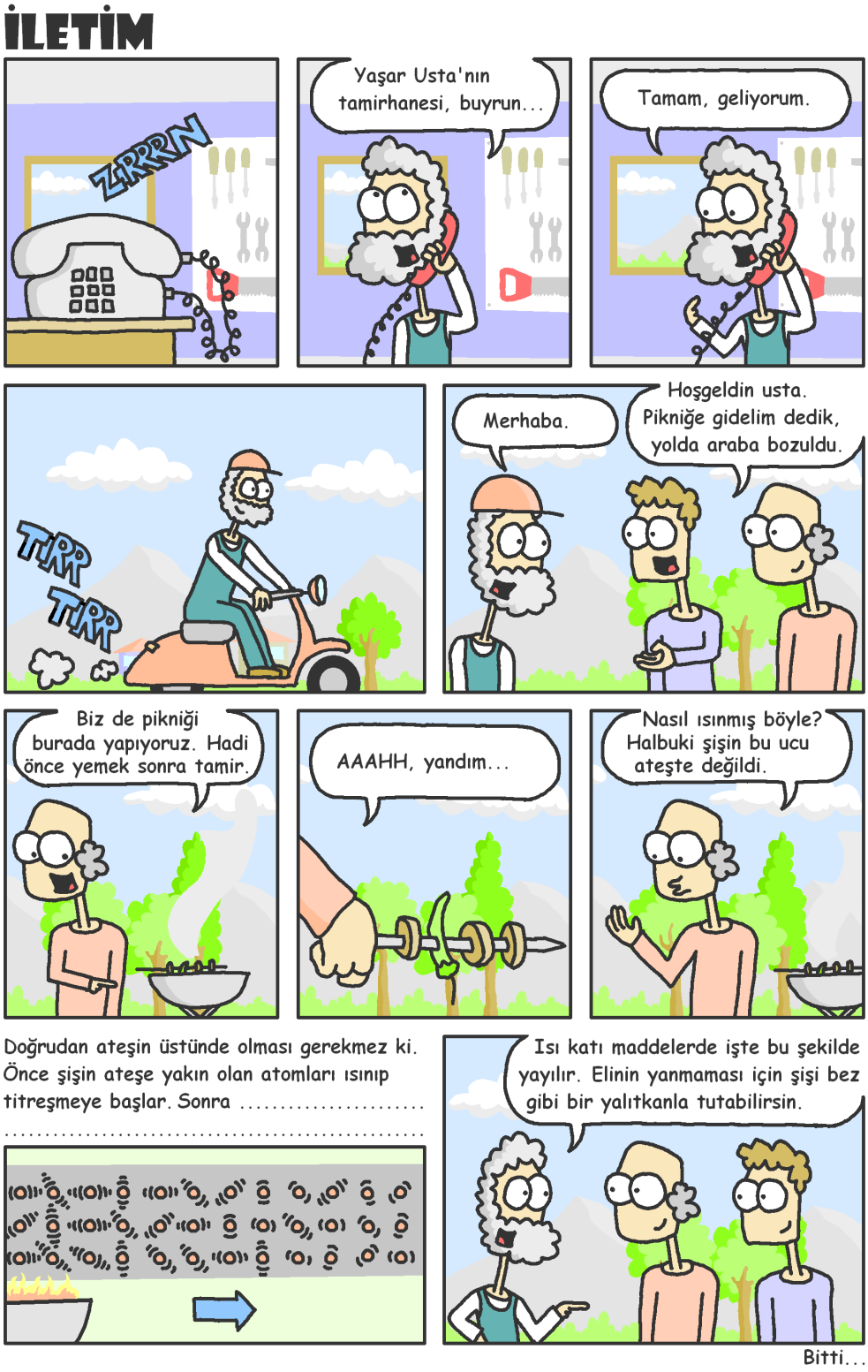

Figure B.2 Final Comic Story about Heat Conduction

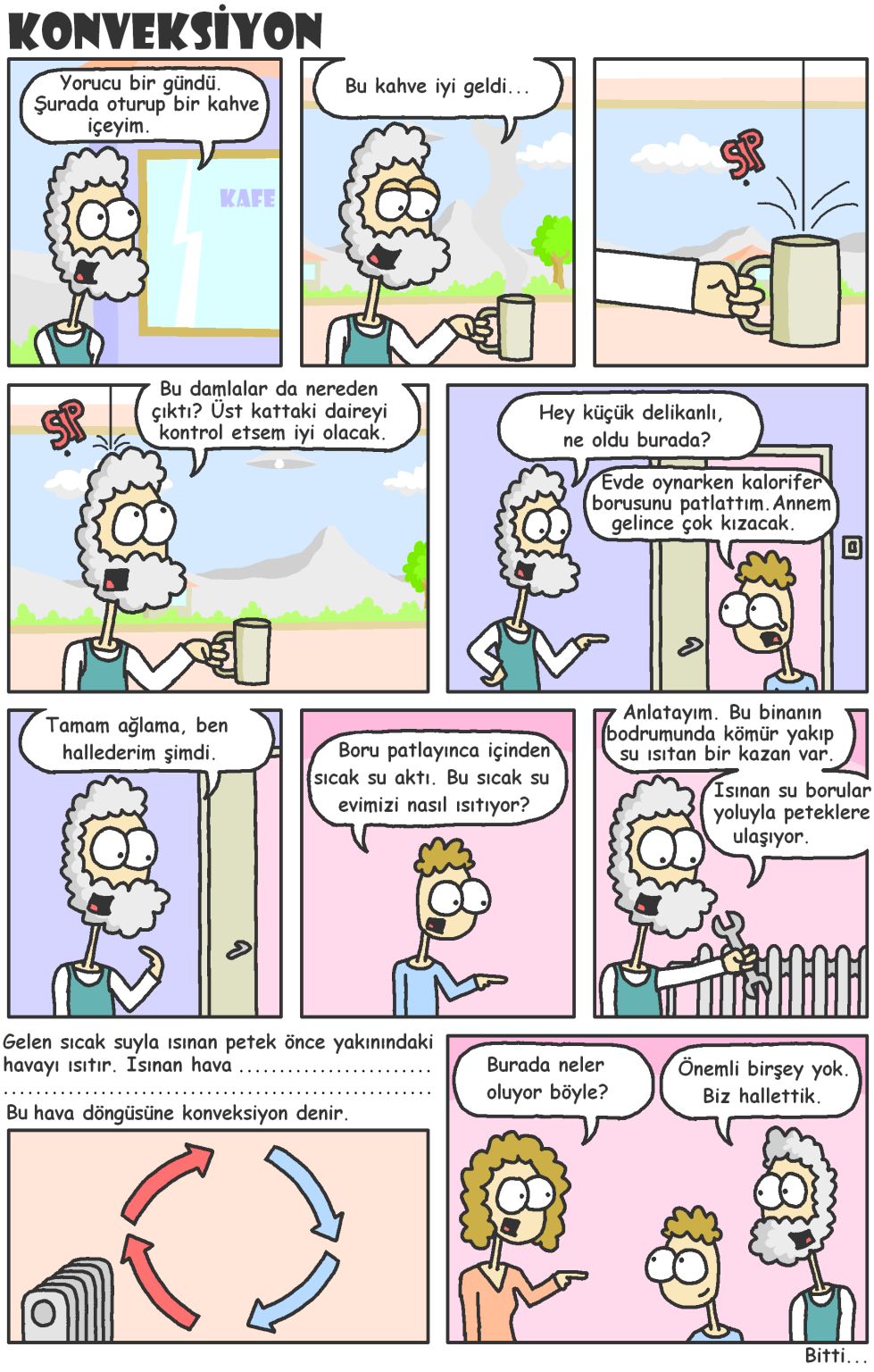

Figure B.3 Final Comic Story about Heat Convection

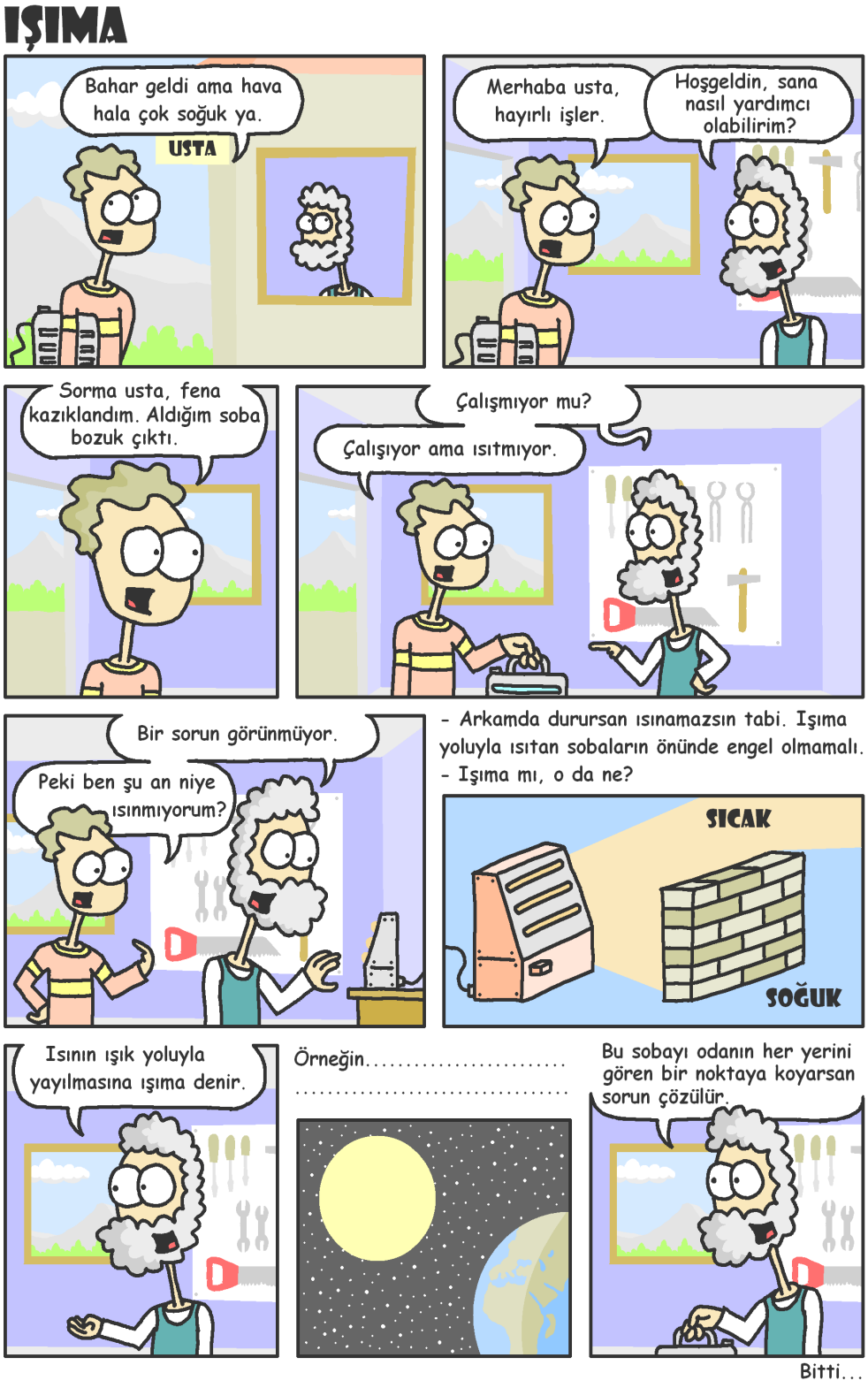

Figure B.4 Final Comic Story about Radiation

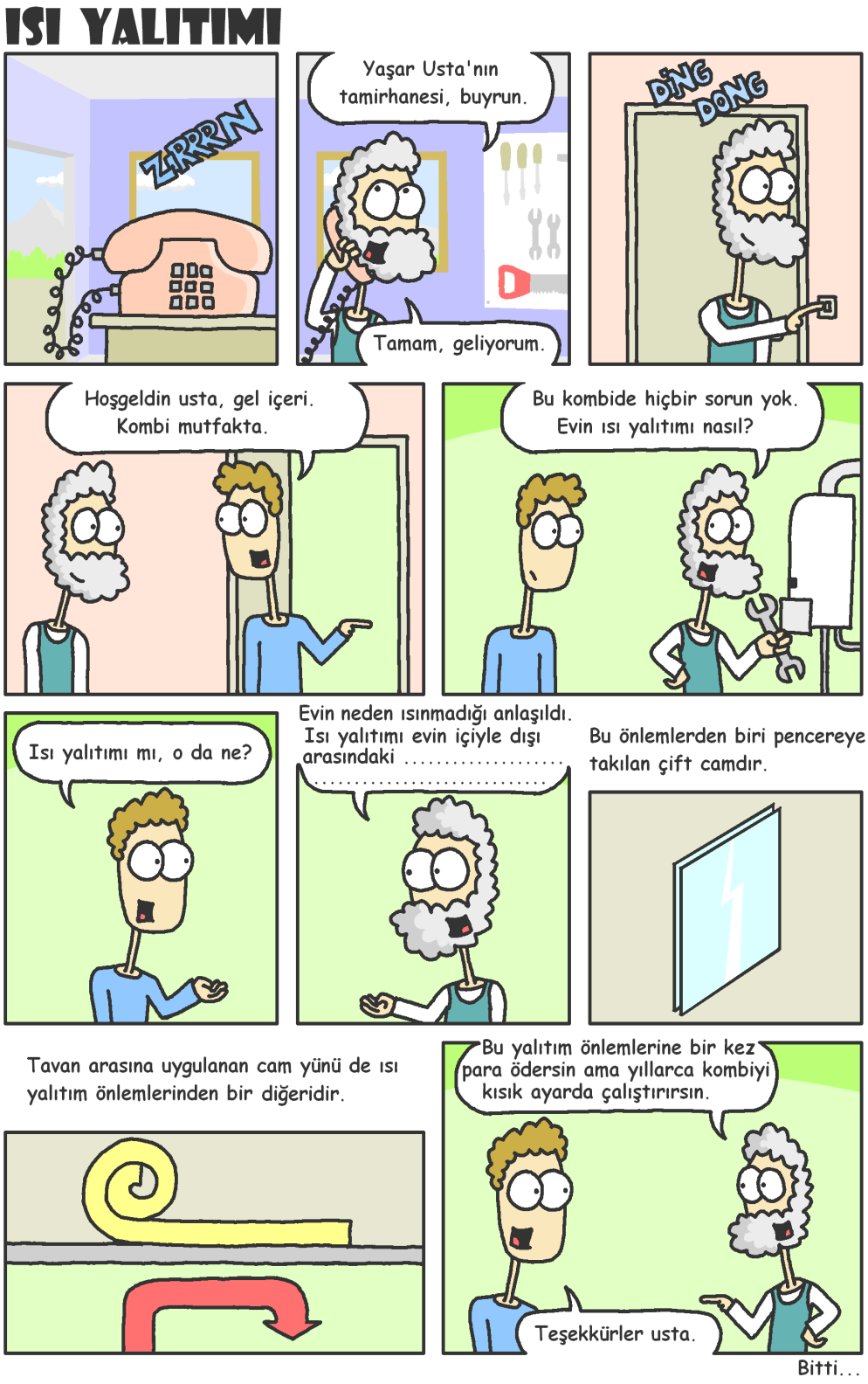

Figure B.5 Final Comic Story about Heat Insulation

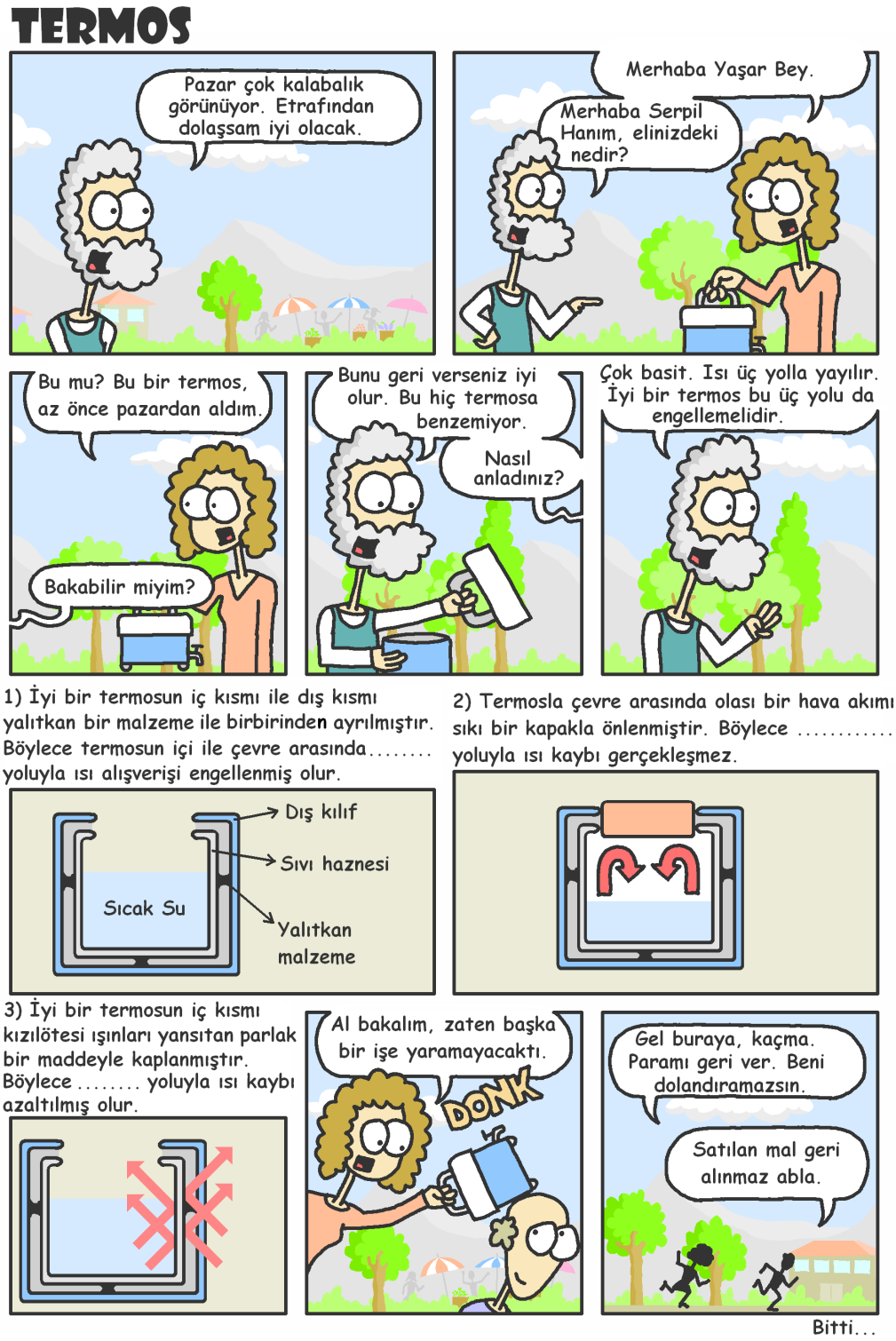

Figure B.6 Final Comic Story about Thermoses

APPENDIX C

EXPERT OPINION FORM FOR INSTRUCTIONAL COMICS

Ekte, 6.sınıf madde ve ısı ünitesinin kazanımları için hazırlanmış bir dizi eğitici çizgiroman ve bu çizgiromanların ders içinde ne şekilde uygulanacağına rehberlik eden bir ders planı bulunmaktadır.

Ekteki ders planının belirttiği biçimde uygulanmak üzere hazırlanan bu çizgiromanları aşağıdaki ölçütlere göre değerlendirip görüşlerinizi tablodaki açıklamalar bölümüne yazabilir misiniz.

Ölçütler:

1. Çizgiromanlar öğrenciler tarafından okunduğunda kolayca anlaşılacak kadar açık olmalı.
2. Çizgiromanlar belirtilen kazanımlara uygun olmalı.
3. Çizgiromanlar bilimsel hata veya kavram yanılgısı içermemeli.

Çizgiroman Uzman Görüşü Formu

Kazanımlar	**Öyküler**	**Açıklamalar**
1. Gözlem yaparak maddeler ısındıkça moleküllerin hızlandığı sonucuna varır.	1	
2. Maddeler arası ısı aktarımı ile atom-moleküllerin çarpışması arasında ilişki kurar.	1 (Tartışma içinde)	
3. Katılarda ısı iletimini deney ile gösterir.	2	

Çizgiroman Uzman Görüşü Formu (Devamı)

Kazanımlar	Öyküler	Açıklamalar
4. Isıyı iyi ileten katıları ısı iletkeni şeklinde adlandırır.	2, 5, 6	
5. Isıyı iyi iletmeyen katıları ısı yalıtkanı şeklinde adlandırır.	2, 5, 6	
6. Gündelik gözlemlerinden, doğrudan temas olmadan ısı aktarımı olabileceği çıkarımını yapar.	4	
7. Isının ışıma yoluyla (görünmez ışınlarla) yayılabileceğini belirtir.	4	
8. Geceleri yeryüzünün neden soğuduğunu sorgulayıp açıklar.	4	
9. Yüzeyi koyu renkli cisimlerin, açık renklilerden daha hızlı ısınmasının sebebini açıklar.	6 (Tartışma içinde)	
10. Isı yalıtım kaplarının yüzeylerinin neden parlak kaplandığını izah eder.	6	
11. Sıvılarda konveksiyon ile ısı yayılmasını deneyle gösterir.	3	
12. Isının iletim, konveksiyon ve ışıma yolu ile yayıldığı durumları ayırt eder.	6	
13. Yalıtımın hangi durumlarda gerekli olabileceğini tahmin eder.	5,6	
14. Yalıtım yerine iletimin tercih edildiği durumlara örnekler verir.	6 (Tartışma içinde)	
15. Yaygın ısı yalıtım malzemelerine örnek verir; yalıtım malzemelerinin yanma özelliklerini ve ömürlerini de hesaba katarak değişik amaçlar için malzeme önerir.	5, 6	
16. Binalarda yalıtımın enerji tüketimi ile ilişkisini açıklar.	5	

APPENDIX D

EXPERT OPINION FORM FOR ACHIEVEMENT TEST WITH BACKGROUND QUESTIONS

Ekte, 6. sınıf öğrencilerinin fenden hoşlanma ve fen dersindeki başarılarını algılama derecelerini ölçmeyi amaçlayan bir ölçek ve madde ve ısı ünitesinin kazanımları için hazırlanmış bir başarı testinden oluşan bir ölçme aracı bulunmaktadır.

Bu ölçme aracını aşağıdaki ölçütlere göre değerlendirip görüşlerinizi tablodaki açıklamalar bölümüne yazabilir misiniz.

Ölçütler:

- Sorular öğrenciler tarafından okunduğunda kolayca anlaşılacak kadar açık olmalı.
- Sayfa düzeni soruların anlaşılırlığını bozmamalı.
- Sorular belirtilen kazanımlara uygun olmalı.
- Seçenekler cevaba dair ipuçları içermemeli.
- Sorular bilimsel hata içermemeli.
- Kullanılan görseller anlaşılır olmalı.

Ölçme Aracı Uzman Görüşü Formu

Kazanımlar	**Sorular**	**Açıklamalar**
1. Gözlem yaparak maddeler ısındıkça moleküllerin hızlandığı sonucuna varır.	1	
2. Maddeler arası ısı aktarımı ile atom-moleküllerin çarpışması arasında ilişki kurar.	2	
3. Katılarda ısı iletimini deney ile gösterir.	3	

Ölçme Aracı Uzman Görüşü Formu (Devamı)

Kazanımlar	Sorular	Açıklamalar
4. Isıyı iyi ileten katıları ısı iletkeni şeklinde adlandırır.	4	
5. Isıyı iyi iletmeyen katıları ısı yalıtkanı şeklinde adlandırır.	5, 6	
6. Gündelik gözlemlerinden, doğrudan temas olmadan ısı aktarımı olabileceği çıkarımını yapar.	7	
7. Isının ışıma yoluyla (görünmez ışınlarla) yayılabileceğini belirtir.	7	
8. Geceleri yeryüzünün neden soğuduğunu sorgulayıp açıklar.	17	
9. Yüzeyi koyu renkli cisimlerin, açık renklilerden daha hızlı ısınmasının sebebini açıklar.	8	
10. Isı yalıtım kaplarının yüzeylerinin neden parlak kaplandığını izah eder.	15	
11. Sıvılarda konveksiyon ile ısı yayılmasını deneyle gösterir.	9	
12. Isının iletim, konveksiyon ve ışıma yolu ile yayıldığı durumları ayırt eder.	10, 11, 12	
13. Yalıtımın hangi durumlarda gerekli olabileceğini tahmin eder.	13	
14. Yalıtım yerine iletimin tercih edildiği durumlara örnekler verir.	16	
15. Yaygın ısı yalıtım malzemelerine örnek verir; yalıtım malzemelerinin yanma özelliklerini ve ömürlerini de hesaba katarak değişik amaçlar için malzeme önerir.	5, 6, 14	
16. Binalarda yalıtımın enerji tüketimi ile ilişkisini açıklar.	14	

Ölçek (Ölçekle ilgili görüşlerinizi buraya yazabilirsiniz.)

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APPENDIX E

RESULTS OF ITEM ANALYSIS IN THE PILOT STUDY

Table E.1 Output of Item Analysis in the Pilot Study

		Item Statistics			Alternative Statistics				
Seq. No.	Scale -Item	Prop. Correct	Biser.	Point Biser.	Alt.	Prop. Endorsing	Biser.	Point Biser.	Key
1	0-1	0.468	0.180	0.143	1	0.129	-0.379	-0.238	
					2	0.468	0.180	0.143	*
					3	0.355	-0.005	-0.004	
					4	0.032	0.199	0.082	
					Other	0.016	-0.105	-0.034	
2	0-2	0.516	0.377	0.301	1	0.177	-0.334	-0.227	
					2	0.081	0.126	0.069	
					3	0.226	-0.274	-0.197	
					4	0.516	0.377	0.301	*
					Other	0.000	-9.000	-9.000	
3	0-3	0.968	0.752	0.307	1	0.968	0.752	0.307	*
					2	0.000	-9.000	-9.000	
					3	0.000	-9.000	-9.000	
					4	0.032	-0.752	-0.307	
					Other	0.000	-9.000	-9.000	
4	0-4	0.903	0.516	0.299	1	0.032	-0.435	-0.178	
					2	0.903	0.516	0.299	*
					3	0.048	-0.412	-0.193	
					4	0.016	-0.390	-0.125	
					Other	0.000	-9.000	-9.000	
5	0-5	0.468	0.482	0.384	1	0.081	-0.448	-0.246	
					2	0.065	-0.180	-0.092	
					3	0.468	0.482	0.384	*
					4	0.387	-0.266	-0.209	
					Other	0.000	-9.000	-9.000	

Table E.1 Output of Item Analysis in the Pilot Study (Continued)

		Item Statistics			Alternative Statistics				
Seq. No.	Scale -Item	Prop. Correct	Biser.	Point Biser.	Alt.	Prop. Endorsing	Biser.	Point Biser.	Key
6	0-6	0.806	0.666	0.462	1	0.145	-0.795	-0.515	
					2	0.806	0.666	0.462	*
					3	0.032	0.041	0.017	
					4	0.016	-0.105	-0.034	
					Other	0.000	-9.000	-9.000	
7	0-7	0.581	0.107	0.085	1	0.581	0.107	0.085	*
					2	0.032	-0.355	-0.145	
	CHECK THE KEY				3	0.097	-0.684	-0.396	
	1 was specified, 4 works better				4	0.290	0.295	0.223	?
					Other	0.000	-9.000	-9.000	
8	0-8	0.661	0.682	0.527	1	0.081	-0.678	-0.372	
					2	0.661	0.682	0.527	*
					3	0.016	0.179	0.057	
					4	0.242	-0.498	-0.363	
					Other	0.000	-9.000	-9.000	
9	0-9	0.532	0.583	0.465	1	0.371	-0.350	-0.273	
					2	0.016	-0.816	-0.261	
					3	0.081	-0.448	-0.246	
					4	0.532	0.583	0.465	*
					Other	0.000	-9.000	-9.000	
10	0-10	0.500	0.646	0.515	1	0.145	-0.419	-0.271	
					2	0.500	0.646	0.515	*
					3	0.097	-0.450	-0.261	
					4	0.242	-0.277	-0.202	
					Other	0.016	0.037	0.012	
11	0-11	0.806	0.937	0.651	1	0.048	-0.355	-0.166	
					2	0.806	0.937	0.651	*
					3	0.048	-0.811	-0.380	
					4	0.081	-0.793	-0.436	
					Other	0.016	-0.532	-0.170	
12	0-12	0.581	0.781	0.618	1	0.097	-0.750	-0.435	
					2	0.113	-0.245	-0.148	
					3	0.581	0.781	0.618	*
					4	0.194	-0.436	-0.303	
					Other	0.016	-0.247	-0.079	

Table E.1 Output of Item Analysis in the Pilot Study (Continued)

		Item Statistics			Alternative Statistics				
Seq. No.	Scale -Item	Prop. Correct	Biser.	Point Biser.	Alt.	Prop. Endorsing	Biser.	Point Biser.	Key
13	0-13	0.661	0.776	0.600	1	0.661	0.776	0.600	*
					2	0.065	-0.589	-0.302	
					3	0.048	-0.811	-0.380	
					4	0.210	-0.430	-0.304	
					Other	0.016	-0.105	-0.034	
14	0-14	0.419	0.699	0.554	1	0.226	-0.274	-0.197	
					2	0.242	-0.369	-0.269	
					3	0.419	0.699	0.554	*
					4	0.113	-0.394	-0.239	
					Other	0.000	-9.000	-9.000	
15	0-15	0.871	0.842	0.528	1	0.048	-0.697	-0.326	
					2	0.048	-0.526	-0.246	
					3	0.032	-0.752	-0.307	
					4	0.871	0.842	0.528	*
					Other	0.000	-9.000	-9.000	

Scale Statistics

Scale:	0
N of Items	15
N of Examinees	62
Mean	9.742
Variance	7.933
Std. Dev.	2.817
Skew	-0.303
Kurtosis	-0.497
Minimum	3.000
Maximum	15.000
Median	10.000
Alpha	0.671
SEM	1.617
Mean P	0.649
Mean Item-Tot.	0.429
Mean Biserial	0.602

APPENDIX F

INITIAL FORM OF ACHIEVEMENT TEST WITH BACKGROUND QUESTIONS

MADDE VE ISI ÜNİTESİ TESTİ

Adınız, Soyadınız:
Aşağıdaki soruları, seçeneklerden yalnız birini yuvarlak içine alarak cevaplayınız.

Genel Bilgiler:

1. Cinsiyetiniz nedir? **a)** Kız **b)** Erkek

2. Babanızın eğitim durumu?
a) Okula gitmemiş **b)** İlkokul mezunu
c) Ortaokul mezunu **d)** Lise mezunu
e) Üniversite mezunu **f)** Yüksek Lisans

3. Annenizin eğitim durumu?
a) Okula gitmemiş **b)** İlkokul mezunu
c) Ortaokul mezunu **d)** Lise mezunu
e) Üniversite mezunu **f)** Yüksek Lisans

4. Çalışma odanız var mı? **a)** Var **b)** Yok

5. Bilgisayarınız var mı? **a)** Var **b)** Yok

6. Evde internet var mı? **a)** Var **b)** Yok

7. Fen ve Teknoloji dersi zor bir derstir.
a) Kesinlikle katılıyorum **b)** Katılıyorum
c) Emin değilim **d)** Katılmıyorum
e) Kesinlikle Katılmıyorum

8. Fen konuları ilgimi çekiyor.
a) Kesinlikle katılıyorum **b)** Katılıyorum
c) Emin değilim **d)** Katılmıyorum
e) Kesinlikle Katılmıyorum

9. Fen ve Teknoloji dersinde, gerekli ve önemli bilgiler öğreniyorum.
a) Kesinlikle katılıyorum **b)** Katılıyorum
c) Emin değilim **d)** Katılmıyorum
e) Kesinlikle Katılmıyorum

10. Kendimi fen konularında yetenekli buluyorum.
a) Kesinlikle katılıyorum **b)** Katılıyorum
c) Emin değilim **d)** Katılmıyorum
e) Kesinlikle Katılmıyorum

11. Fen konularını seviyorum.
a) Kesinlikle katılıyorum **b)** Katılıyorum
c) Emin değilim **d)** Katılmıyorum
e) Kesinlikle Katılmıyorum

12. Fen ve Teknoloji dersinde öğrendiklerimi gündelik hayatımda kullanıyorum.
a) Kesinlikle katılıyorum **b)** Katılıyorum
c) Emin değilim **d)** Katılmıyorum
e) Kesinlikle Katılmıyorum

13. Ders dışında da fenle ilgili etkinlikler yapıyorum.
a) Sık sık **b)** Genellikle
c) Bazen **d)** Nadiren **e)** Hiçbir zaman

14. Ders kitabı dışında fenle ilgili kitaplar okurum.
a) Sık sık **b)** Genellikle
c) Bazen **d)** Nadiren **e)** Hiçbir zaman

Başarı Testi

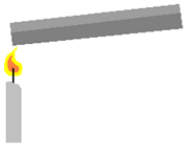
1. Aşağıdaki seçeneklerden hangisi madde ve ısı arasındaki ilişkiyi doğru bir biçimde tanımlamaktadır?

a) Bir madde ısıtıldığında o maddedeki ısı parçacıklarının sayısı artar.
b) Bir madde ısıtıldığında o maddeyi oluşturan atomlar hızlanır.
c) Isı maddelerin temel özelliklerinden biridir, farklı maddeler farklı ısılara sahiptir.
d) Isı maddelerin kütlesi ile ilgili bir özelliktir, ağır maddeler hafif maddelere göre daha az ısıya sahiptir.

2. Maddeler arasındaki ısı aktarımı ile ilgili aşağıdakilerden hangisi doğrudur?

a) Maddeler arası ısı aktarımı ısı parçacıklarının bir maddeden diğerine geçmesiyle gerçekleşir.
b) Maddeler arası ısı aktarımı aşağıdaki cisimden yukarıdakine doğrudur.
c) Isı kütlesi büyük olan cisimden küçük olan cisme aktarılır.
d) Maddeler arası ısı alışverişi atomların birbirleriyle çarpışması sonucu gerçekleşir.

3. Bir demir çubuk bir ucundan şekildeki gibi ısıtılmaktadır. Bu çubukla ilgili aşağıdaki durumlardan hangisi doğrudur?



a) Bir süre sonra demir çubuğun öteki ucu da ısınır.
b) Demir çubuğun öteki ucu mumun alevine uzak olduğu için ısınmaz.
c) Isı, demir çubuğun içinde ilerleyemediği için diğer uç ısınmaz.
d) Demir, çubuk biçiminde olduğu için öteki uç ısınamaz.

4. Aşağıdaki katı maddelerden hangisinin ısıyı diğerlerine göre iyi iletmesi beklenir?

a) Tahta
b) Demir
c) Plastik
d) Pamuk

5. İçine koyulan sıcak ya da soğuk bir cismin sıcaklığını uzun süre koruyabilecek bir kabı aşağıdaki maddelerden hangisi ile üretirdiniz?

a) Bakır
b) Demir
c) Plastik
d) Aluminyum

6. Şekilde görüldüğü gibi, güneşli bir günde bir mercek kullanılarak bir kağıt parçası yakılabilir. Aşağıdakilerden hangisi bu olayı doğru bir biçimde açıklamaktadır?

a) Güneş, merceği ısıtır ve ısınan merceğin sıcaklığıyla kağıt yanar.
b) Güneş ışınları mercek tarafından kağıda odaklanarak onu ışıma yoluyla ısıtıp yakar.
c) Güneş ışınları mercekten geçtikten sonra kağıtla mercek arasındaki havayı ısıtırarak kağıdı yakar.
d) Mercek, üzerinden geçen güneş ışınlarını ısı parçacıklarına dönüştererek kağıdı yakar.

7. Aşağıdakilerden hangisi geceleri yeryüzünün soğumasının sebebidir?

a) Gündüz ışıma yoluyla yeryüzünü ısıtan güneş ışınları gece yoktur.
b) Gündüz Güneş'ten gelen sıcak hava geceleri yoktur.
c) Gündüz Güneş'ten gelen ısı parçacıkları geceleri yoktur.
d) Gündüz ısınan hava geceleri yükselir.

8. Yazları çok sıcak olan bir şehirde yaşayanlar için, hangi renk giysiler en uygundur? Neden?

a) Koyu renkli kıyafetler uygundur, çünkü koyu renkli kıyafetler daha az güneş ışığını yansıtır.
b) Açık renkli kıyafetler uygundur, çünkü açık renkli kıyafetler daha çok güneş ışığını yansıtır.
c) Koyu renkli kıyafetler uygundur, çünkü koyu renkli kıyafetler daha çok güneş ışığını yansıtır.
d) Açık renkli kıyafetler uygundur, çünkü açık renkli kıyafetler daha az güneş ışığını yansıtır.

9. Sıcak veya soğuk sıvıların ılımasını önlemek için kullandığımız termosların dış yüzeyleri parlak bir maddeyle kaplanır. Bunun nedeni aşağıdakilerden hangisi olabilir?

a) Termosun dış yüzeyinin hava ile temasını azaltmak için.
b) Termosun dış yüzeyini kalınlaştırmak için.
c) Termosun içini karanlık hale getirmek için.
d) Isıtıcı etkisi olan kızılötesi ışınların termosun içine girmesini önlemek için.

10. Bir kabın içinde şekildeki gibi ısıtılan bir sıvı ile ilgili aşağıdakilerden hangisi **yanlıştır**?

a) Sıvı ısındıkça sıvı moleküllerinin hareketliliği artar.
b) Sıvı ısındıkça sıvı içindeki ısı parçacıklarının miktarı artar.
c) Sıvı ısındıkça sıvı moleküllerinin çarpışmaları artar.
d) Sıvı ısındıkça sıvı içinde kabın alt kısmından üst kısmına doğru bir akış gerçekleşir.

11. Aşağıda verilen durumlardan hangisi ısının iletim yoluyla yayılmasına örnektir?

a) Alt kısmından ısıtılan bir kap suyun zamanla üst kısımlarının ısınması.
b) Bir ucundan ısıtılan bir metal çubuğun zamanla öteki ucunun ısınması.
c) Güneşli bir günde arabanın dış yüzeyinin ısınması.
d) Güneşli bir günde mercekle kağıdın yakılması.

12. Aşağıdakilerden hangisi ısının konveksiyon yoluyla yayılmasına bir örnektir?

a) Bir ucundan ısıtılan bir metal çubuğun zamanla öteki ucunun ısınması.
b) Güneşli bir günde arabanın dış yüzeyinin ısınması.
c) Alt kısmından ısıtılan bir kap suyun zamanla üst kısımlarının ısınması.
d) Bir bardak sıcak çayın içine bırakılan çay kaşığının zamanla ısınması.

13. Aşağıdakilerden hangisi ısının ışıma yoluyla yayılmasına bir örnektir?

a) Güneşli bir günde arabanın dış yüzeyinin ısınması.
b) Alt kısmından ısıtılan bir kap suyun zamanla üst kısımlarının ısınması.
c) Bir bardak sıcak çayın içine bırakılan çay kaşığının zamanla ısınması.
d) Kalorifer peteği üzerinde ısınan havanın yükselmesi.

14. Aşağıdakilerden hangisi ısı yalıtımının gerekli olduğu durumlardan biri **değildir**?

a) Isıtılmış bir miktar çayın uzun süre sıcaklığının korunması.
b) Buzun uzun süre erimemesinin sağlanması.
c) Otomobillerde ısınan motorun soğutulması.
d) Kış mevsiminde evlerin ısıtılması.

15. Kışın, ısınma giderleri yüksek olduğu halde yeterince ısıtılamayan bir ev için aşağıdakilerden hangisi bu sorunun çözümüne yardımcı **olmaz**?

a) Pencerelere çift-cam takılması.
b) Balkon kapıları ve pencere kenarlarına sünger yapıştırılması.
c) Çatıya cam yünü döşenmesi.
d) Daha ucuz bir yakıt kullanılması.

APPENDIX G

FINAL FORM OF ACHIEVEMENT TEST WITH BACKGROUND QUESTIONS

MADDE VE ISI ÜNİTESİ TESTİ

Adınız, Soyadınız:

Bir doktora çalışması kapsamında hazırlanan bu testin sonuçlarının geçerli ve güvenilir olması için soruları samimi ve özenli bir biçimde ve seçeneklerden yalnız birini yuvarlak içine alarak yanıtlayınız.

Ertuğrul ÖZDEMİR

Genel Bilgiler:

1. Cinsiyetiniz nedir? **a)** Kız **b)** Erkek

2. Babanızın eğitim durumu?
a) Okula gitmemiş **b)** İlkokul mezunu
c) Ortaokul mezunu **d)** Lise mezunu
e) Üniversite mezunu **f)** Yüksek Lisans

3. Annenizin eğitim durumu?
a) Okula gitmemiş **b)** İlkokul mezunu
c) Ortaokul mezunu **d)** Lise mezunu
e) Üniversite mezunu **f)** Yüksek Lisans

4. Evde kendi odanız var mı? **a)** Var **b)** Yok

5. Kendi bilgisayarınız var mı? **a)** Var **b)** Yok

6. Evde internet var mı? **a)** Var **b)** Yok

7. ile 15. arasındaki soruları tablodaki uygun yerlere çarpı (X) işareti koyarak yanıtlayınız.

	Kesinlikle katılıyorum	Katılıyorum	Emin değilim	Katılmıyorum	Kesinlikle katılmıyorum
7. Fen konularını seviyorum.					
8. Ders kitabı dışında fenle ilgili kitaplar okumaktan hoşlanıyorum.					
9. Fen ve teknoloji ile ilgili dergileri okumaktan hoşlanıyorum.					
10. Fen ve teknoloji ile ilgili televizyon belgesellerini izlemekten hoşlanıyorum.					
11. Fen ve Teknoloji dersinde öğrendiklerim hoşuma gidiyor.					
12. Kendimi fen konularında yetenekli buluyorum.					
13. Fen ve Teknoloji dersi bana kolay geliyor.					
14. Fen konularını anlamakta zorlanıyorum.					
15. Kendimi Fen ve Teknoloji dersinde başarılı buluyorum.					

Başarı Testi

1. Bir madde ısıtıldığında;
I. O maddedeki ısı parçacıklarının sayısı artar.
II. O maddeyi oluşturan atomlar hızlanır.
III. O maddedeki soğuk parçacıklar o maddeden ayrılır.
Bir madde ısıtıldığında, o maddenin yapısında yukarıdaki değişikliklerden hangisi ya da hangileri gözlemlenir?

a) Yalnız I **b)** I ve II
c) Yalnız II **d)** Yalnız III

2. Sıcaklıkları farklı birbirine temas eden iki madde arasındaki ısı aktarımı ile ilgili olarak;
I. İki madde arası ısı aktarımı ısı parçacıklarının bir maddeden diğerine geçmesiyle gerçekleşir.
II. Isı kütlesi büyük olan cisimden küçük olan cisme aktarılır.
III. İki madde arasındaki ısı alışverişi taneciklerin birbirleriyle çarpışması sonucu gerçekleşir.
Bu maddelerle ilgili yukarıdakilerden hangisi ya da hangileri doğrudur?

a) Yalnız I **b)** I ve II
c) II ve III **d)** Yalnız III

3. Bir ucundan şekildeki gibi ısıtılan bir demir çubukla ilgili olarak;

I. Bir süre sonra demir çubuğun öteki ucu da ısınır.
II. Demir çubuğun öteki ucu mumun alevine uzak olduğu için ısınmaz.
III. Isı, demir çubuğun içinde ilerleyemediği için diğer uç ısınmaz.
Bu demir çubukla ilgili yukarıdakilerden hangisi ya da hangileri doğrudur.

a) Yalnız I **b)** II ve III
c) Yalnız II **d)** Yalnız III

4. Aşağıdaki katı maddelerden hangisinin ısıyı diğerlerine göre iyi iletmesi beklenir?

a) Tahta **c)** Plastik
b) Demir **d)** Pamuk

5. İçine koyulan sıcak ya da soğuk bir cismin sıcaklığını uzun süre koruyabilecek bir kabı aşağıdaki maddelerden hangisi ile üretirdiniz?

a) Bakır **c)** Plastik
b) Demir **d)** Aluminyum

6. Evinizin ısı yalıtımı için aşağıdaki malzemelerden hangisini KULLANMAZSINIZ?

a) Cam yünü **c)** Çelik
b) Taş yünü **d)** Strafor

7. Şekilde görüldüğü gibi, güneşli bir günde bir mercek kullanılarak bir kağıt parçası yakılabilir. Aşağıdakilerden hangisi bu olayı doğru bir biçimde açıklamaktadır?

a) Güneş, merceği ısıtır ve ısınan merceğin sıcaklığıyla kağıt yanar.
b) Güneş ışınları mercek tarafından kağıda odaklanarak onu ışıma yoluyla ısıtıp yakar.
c) Güneş ışınları mercekten geçtikten sonra kağıtla mercek arasındaki havayı ısıtırarak kağıdı yakar.
d) Mercek, üzerinden geçen güneş ışınlarını ısı parçacıklarına dönüştererek kağıdı yakar.

8. Yazları çok sıcak olan bir şehirde yaşayanlar için, hangi renk giysiler en uygundur? Neden?

a) Koyu renkli kıyafetler uygundur, çünkü koyu renkli kıyafetler daha az güneş ışığını yansıtır.
b) Açık renkli kıyafetler uygundur, çünkü açık renkli kıyafetler daha çok güneş ışığını yansıtır.
c) Koyu renkli kıyafetler uygundur, çünkü koyu renkli kıyafetler daha çok güneş ışığını yansıtır.
d) Açık renkli kıyafetler uygundur, çünkü açık renkli kıyafetler daha az güneş ışığını yansıtır.

9. Bir kabın içinde şekildeki gibi ısıtılan bir sıvı ile ilgili olarak;

I. Isındıkça sıvıyı oluşturan taneciklerin hareketliliği artar.
II. Isındıkça sıvı içindeki ısı parçacıklarının miktarı artar.
III. Isındıkça sıvıyı oluşturan taneciklerin çarpışmaları artar.

Bu sıvıyla ilgili yukarıdakilerden hangisi ya da hangileri doğrudur?

a) Yalnız I **b)** I ve II
c) Yalnız II **d)** I ve III

10. Aşağıda verilen durumlardan hangisi ısının iletim yoluyla yayılmasına örnektir?

a) Alt kısmından ısıtılan bir kap suyun zamanla üst kısımlarının ısınması.
b) Bir ucundan ısıtılan bir metal çubuğun zamanla öteki ucunun ısınması.
c) Güneşli bir günde arabanın dış yüzeyinin ısınması.
d) Güneşli bir günde mercekle kağıdın yakılması.

11. Aşağıdakilerden hangisi ısının konveksiyon yoluyla yayılmasına bir örnektir?

a) Bir ucundan ısıtılan bir metal çubuğun zamanla öteki ucunun ısınması.
b) Güneşli bir günde arabanın dış yüzeyinin ısınması.
c) Alt kısmından ısıtılan bir kap suyun zamanla üst kısımlarının ısınması.
d) Bir bardak sıcak çayın içine bırakılan çay kaşığının zamanla ısınması.

12. Aşağıdakilerden hangisi ısının ışıma yoluyla yayılmasına bir örnektir?

a) Güneşli bir günde arabanın dış yüzeyinin ısınması.
b) Alt kısmından ısıtılan bir kap suyun zamanla üst kısımlarının ısınması.
c) Bir bardak sıcak çayın içine bırakılan çay kaşığının zamanla ısınması.
d) Kalorifer peteği üzerinde ısınan havanın yükselmesi.

13. Aşağıdakilerden hangisi ısı yalıtımının gerekli olduğu durumlardan biri DEĞİLDİR?

a) Isıtılmış bir miktar çayın sıcaklığının uzun süre korunması.
b) Buzun erimesinin uzun süre engellenmesi.
c) Dondurulmuş gıdaların çözülmesi.
d) Kış mevsiminde evlerin ısıtılması.

14. Kışın, ısınma giderleri yüksek olduğu halde yeterince ısıtılamayan bir ev için aşağıdakilerden hangisi bu sorunun çözümüne yardımcı OLMAZ?

a) Pencerelere çift-cam takılması.
b) Balkon kapıları ve pencere kenarlarına sünger yapıştırılması.
c) Çatıya cam yünü döşenmesi.
d) Isıtıcının daha yüksek derecede çalıştırılması.

15. Sıcak veya soğuk sıvıların ılımasını önlemek için kullandığımız termosların dış yüzeyleri parlak bir maddeyle kaplanır. Bunun nedeni aşağıdakilerden hangisi olabilir?

a) Termosun dış yüzeyinin hava ile temasını azaltmak için.
b) Termosun dış yüzeyini kalınlaştırmak için.
c) Termosun içini karanlık hale getirmek için.
d) Isıtıcı etkisi olan görünmez ışınların termosun içine girmesini önlemek için.

16. Aşağıdakilerden hangisi iyi ısı iletiminin gerekli olduğu durumlardan biri DEĞİLDİR?

a) Bir miktar çayın sıcak tutulması.
b) Dondurulmuş gıdaların çözülmesi.
c) Bir kalorifer peteğinin ısınması.
d) Yemeğin tencerede daha çabuk pişmesinin sağlanması.

17. Aşağıdakilerden hangisi geceleri yeryüzünün soğumasının sebebidir?

a) Gündüz Güneş'ten gelen sıcak atomlar geceleri yoktur.
b) Gündüz Güneş'ten gelen sıcak hava geceleri yoktur.
c) Gündüz Güneş'ten gelen ısı tanecikleri geceleri yoktur.
d) Gündüz ışıma yoluyla yeryüzünü ısıtan güneş ışınları geceleri yoktur.

APPENDIX H

OPEN-ENDED QUESTIONNAIRE FOR TEACHERS

1. Bir dizi eğitici çizgiromanı sınıf içinde uyguladınız. Sizce bu öğretim yöntemini geleneksel yöntemlerden üstün kılan özellikleri nelerdir?

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2. Bu yöntemin uygulandığı derslerde öğrencilerin davranışlarında derse katılım ve disiplin açısından ne gibi değişiklikler gözlediniz?

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3. Bu yöntemin uygulandığı ünitede, öğrencilerin başarılarılarında diğer ünitelere göre ne gibi değişiklikler gözlemlediniz?

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4. Sizce bu yöntem kız ve erkek öğrencileri aynı şekilde mi etkiledi?

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5. Sizce bu yöntem başarılı ve başarısız öğrencileri aynı şekilde mi etkiledi?

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6. Sizce bu yöntem düşük gelirli ve yüksek gelirli ailelerden gelen öğrencileri aynı şekilde mi etkiledi?

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7. Sizce bu yöntemin dezavantajları nelerdir?

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8. Sizce bu yöntem nasıl daha etkin hale getirilebilir?

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APPENDIX I

OPEN-ENDED QUESTIONNAIRE FOR STUDENTS

Adınız Soyadınız:

Sınıfınız:

1. Bir dizi eğitici - öğretici çizgiromanı okudunuz. Sizce çizgiroman kullanılması eğitim - öğretim sürecini daha eğlenceli hale getirebiliyor mu? Neden?

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2. Sizce eğitici - öğretici çizgiromanlar etkili bir öğrenme sağlayabiliyor mu? Neden?

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3. Sizce eğitici - öğretici çizgiromanların avantajları nelerdir?

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4. Sizce eğitici - öğretici çizgiromanların dezavantajları nelerdir?

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5. Sizce bu yöntem nasıl daha etkin hale getirilebilir?

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APPENDIX J

LESSON GUIDES

DERS YÖNERGESİ

1. Ders

- "Madde ve Isı" isimli öykünün okunması ve öyküde boş bırakılan kısmın doldurulması için öğrencilere 10 dakika süre verilir.
- Öğrencilerden en az ikisinin öyküyü özetlemesi sağlanır.
- Çok sayıda öğrencinin öyküde boş bırakılan kısma ne yazdığını nedenleriyle birlikte açıklaması sağlanır.
- Öyküde boş bırakılan kısımlarla ilgili farklı görüşlerin ifade edilmesi sağlanarak sınıfta bir tartışma ortamı sağlanır.
- Tartışma sırasında maddeler arası ısı aktarımı ve taneciklerin çarpışması arasındaki ilişki vurgulanır.
- Öğrenciler öyküdeki atom çizimlerinin gerçek boyutta olmadığı konusunda uyarılır.
- Tartışmanın sonunda öyküde boş bırakılan kısma yazılması gereken doğru ifade öğretmen tarafından sınıfa açıklanır.
- Madde ve ısı arasındaki ilişki kısaca öğretmen tarafından özetlenir.

2. Ders

- Dersin başında önceki derste işlenen öykünün en az bir öğrenci tarafından özetlenmesi sağlanır.
- "İletim" isimli öykünün okunması ve öyküde boş bırakılan kısmın doldurulması için öğrencilere 10 dakika süre verilir.
- Öğrencilerden en az ikisinin öyküyü özetlemesi sağlanır.
- Çok sayıda öğrencinin öyküde boş bırakılan kısma ne yazdığını nedenleriyle birlikte açıklaması sağlanır.
- Öyküde boş bırakılan kısımlarla ilgili farklı görüşlerin ifade edilmesi sağlanarak sınıfta bir tartışma ortamı sağlanır.
- Öğrenciler öyküdeki atom çizimlerinin gerçek boyutta olmadığı konusunda uyarılır.
- Tartışmanın sonunda öyküde boş bırakılan kısma yazılması gereken doğru ifade öğretmen tarafından sınıfa açıklanır.
- Isının iletim yoluyla yayılması kısaca öğretmen tarafından özetlenir.

3. Ders

- Dersin başında önceki derste işlenen öykünün en az bir öğrenci tarafından özetlenmesi sağlanır.
- "Konveksiyon" isimli öykünün okunması ve öyküde boş bırakılan kısmın doldurulması için öğrencilere 10 dakika süre verilir.
- Öğrencilerden en az ikisinin öyküyü özetlemesi sağlanır.
- Çok sayıda öğrencinin öyküde boş bırakılan kısma ne yazdığını nedenleriyle birlikte açıklaması sağlanır.
- Öyküde boş bırakılan kısımlarla ilgili farklı görüşlerin ifade edilmesi sağlanarak sınıfta bir tartışma ortamı sağlanır.

- Tartışmanın sonunda öyküde boş bırakılan kısma yazılması gereken doğru ifade öğretmen tarafından sınıfa açıklanır.
- Isının konveksiyon yoluyla yayılması kısaca öğretmen tarafından özetlenir.

4. Ders

- Dersin başında önceki derste işlenen öykünün en az bir öğrenci tarafından özetlenmesi sağlanır.
- "Işıma" isimli öykünün okunması ve öyküde boş bırakılan kısmın doldurulması için öğrencilere 10 dakika süre verilir.
- Öğrencilerden en az ikisinin öyküyü özetlemesi sağlanır.
- Çok sayıda öğrencinin öyküde boş bırakılan kısma ne yazdığını nedenleriyle birlikte açıklaması sağlanır.
- Öyküde boş bırakılan kısımlarla ilgili farklı görüşlerin ifade edilmesi sağlanarak sınıfta bir tartışma ortamı sağlanır.
- Tartışmanın sonunda öyküde boş bırakılan kısma yazılması gereken doğru ifade öğretmen tarafından sınıfa açıklanır.
- Isının ışıma yoluyla yayılması kısaca öğretmen tarafından özetlenir.

5. Ders

- Dersin başında önceki derste işlenen öykünün en az bir öğrenci tarafından özetlenmesi sağlanır.
- "Isı Yalıtımı" isimli öykünün okunması ve öyküde boş bırakılan kısmın doldurulması için öğrencilere 10 dakika süre verilir.
- Öğrencilerden en az ikisinin öyküyü özetlemesi sağlanır.
- Çok sayıda öğrencinin öyküde boş bırakılan kısma ne yazdığını nedenleriyle birlikte açıklaması sağlanır.

- Öyküde boş bırakılan kısımlarla ilgili farklı görüşlerin ifade edilmesi sağlanarak sınıfta bir tartışma ortamı sağlanır.
- Tartışmanın sonunda öyküde boş bırakılan kısma yazılması gereken doğru ifade öğretmen tarafından sınıfa açıklanır.
- Isı yalıtımı konusu kısaca öğretmen tarafından özetlenir.

6. Ders

- Dersin başında önceki derste işlenen öykünün en az bir öğrenci tarafından özetlenmesi sağlanır.
- "Termos" isimli öykünün okunması ve öyküde boş bırakılan kısmın doldurulması için öğrencilere 10 dakika süre verilir.
- Öğrencilerden en az ikisinin öyküyü özetlemesi sağlanır.
- Çok sayıda öğrencinin öyküde boş bırakılan kısma ne yazdığını nedenleriyle birlikte açıklaması sağlanır.
- Öyküde boş bırakılan kısımlarla ilgili farklı görüşlerin ifade edilmesi sağlanarak sınıfta bir tartışma ortamı sağlanır.
- Tartışma sırasında termosların dış yüzeyinin yansıtıcı bir maddeyle kaplanması ile yaz ve kış mevsimlerinde giydiğimiz kıyafetlerin renkleri arasındaki benzerlik vurgulanır.
- Öğrencilerden termos örneğindekinin aksine yalıtım yerine iletimin tercih edildiği durumlara örnekler vermeleri istenir.
- Tartışmanın sonunda öyküde boş bırakılan kısma yazılması gereken doğru ifade öğretmen tarafından sınıfa açıklanır.
- Ünitenin temel kavramları kısaca öğretmen tarafından özetlenir.

APPENDIX K

TREATMENT VERIFICATION CHECKLIST

Treatment Verification Checklist

Test uygulanırken ya da ders sırasındaki gözlemleriniz için aşağıdaki maddeleri işaretleyiniz.

√: Evet X: Hayır N: Bu durum için uygun değil

( ) Dersin başında sınıftaki öğrenci sayısında önemli bir eksiklik var mı?

( ) Öğrenciler dağıtılan testleri bağımsız bir şekilde tamamladılar mı?

( ) Dersin başında önceki derste işlenen öykünün tekrarı öğrencilerin katılımıyla gerçekleştirildi mi?

( ) Öğrenciler derste işlenecek öyküyü okudular mı?

( ) Derste işlenecek öykünün okunması için öğrencilere yeterince zaman verildi mi?

( ) Öykünün okunması bitince, öykünün en az bir öğrenci tarafından özetlenmesi sağlandı mı?

( ) Öykünün özetlenmesi bitince, öğrenciler öyküde boş bırakılmış kısımları doldurdu mu?

( ) Öyküde boş bırakılmış kısımların doldurulması için öğrencilere yeterince zaman verildi mi?

( ) Yeterince sayıda öğrenci öyküde boş bırakılmış kısımlara ne yazdıklarını açıkladı mı?

( ) Öğrenciler boşluklara yazdıklarının nedenini açıkladılar mı?

( ) Boşluklara ne yazılacağına dair sınıfta bir tartışma ortamı oluştu mu?

( ) Öğretmen tartışmanın sonunda boşluğa yazılması gereken doğru ifadeyi söyledi mi?

( ) Tartışmanın sonunda öğretmen öyküde işlenen fen kavramlarını kısaca açıkladı mı?

( ) Ders boyunca öykülerin okunup anlaşılmasını engelleyecek herhangi bir olay yaşandı mı?

( ) Öğretmen ders boyunca ders planı dışında herhangi bir etkinlik yaptırdı mı?

( ) Öğrenciler diğer sınıftaki öğrencilerle rekabet içinde olduklarını düşünüyorlar mı?

( ) Öğrenciler diğer sınıftaki öğrencilerin daha avantajlı olduğunu düşünüyorlar mı?

( ) Öğretmen iki gruptan birini kayıracak bir davranışta bulundu mu? Bulunduysa yazınız.

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( ) Uygulama sürecinde ders sürelerini etkileyen bir olay yaşandı mı? Yaşandıysa yazınız.

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NOTLAR:

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APPENDIX L

RAW DATA

Table L.1 Raw Data

Number	Shcool	Group	Gender	Faed	Moed	Room	Comp	Net	PREACH	POSTACH	HOMER	PARED	PRESUCC	PREENJY	POSTSUCC	POSTENJY
1	1	1	1	6	5	1	2	2	4	8	-0.18	0.99	-3.20	0.98	-2.98	0.92
2	1	1	1	5	5	2	2	2	5	6	0.53	0.94	-1.58	-1.56	-1.45	-1.77
3	1	1	1	4	5	2	2	2	7	11	0.56	0.51	-0.17	1.04	-0.26	1.02
4	1	1	1	2	2	1	1	1	8	10	-1.80	-1.45	-0.53	0.15	0.42	-0.37
5	1	1	2	5	4	2	2	2	6	12	0.67	0.50	-1.00	0.35	-1.04	0.43
6	1	1	2	5	3	1	1	2	5	7	-1.04	0.18	-0.62	1.31	0.37	0.86
7	1	1	2	4	4	2	1	1	6	10	-1.45	0.63	-1.42	0.64	-1.47	1.05
8	1	1	2	5	5	2	2	2	5	9	0.53	0.94	0.43	0.59	0.76	0.68
9	1	1	1	3	3	1	1	1	8	9	-1.96	-0.59	0.10	-0.32	-0.21	0.17
10	1	1	1	5	5	2	1	2	10	16	-0.63	1.41	1.18	0.55	1.17	0.49
11	1	1	2	6	4	2	2	2	8	15	0.64	0.92	0.81	-0.68	0.68	-0.64
12	1	1	1	3	4	2	2	2	10	13	0.72	-0.34	-0.13	-0.03	-0.15	0.37
13	1	1	1	5	4	2	2	2	9	16	0.67	0.50	0.38	0.41	0.30	0.34
14	1	1	2	5	6	2	1	2	4	4	-0.77	1.85	-0.58	-0.02	-0.11	-0.29
15	1	1	1	6	4	2	2	2	9	14	0.64	0.92	2.24	-2.85	2.19	-2.98
16	1	1	1	2	2	2	2	2	6	6	1.03	-1.63	0.20	0.36	0.11	0.33
17	1	1	1	5	3	2	2	2	8	11	0.81	0.07	0.45	0.66	0.37	0.64
18	1	1	2	4	1	2	1	1	4	6	-1.03	-0.67	-0.48	-2.18	-0.65	-2.46
19	1	1	2	4	2	2	2	2	9	13	0.97	-0.78	0.21	0.88	0.50	0.70
20	1	1	1	5	2	2	2	2	11	16	0.94	-0.36	0.65	0.13	0.78	0.15
21	1	1	2	5	5	2	2	2	8	13	0.53	0.94	1.14	0.10	1.13	0.02
22	1	1	2	5	5	2	2	2	9	14	0.53	0.94	0.80	0.71	0.76	0.68
23	1	1	1	4	2	2	2	1	9	15	-0.01	-0.71	-0.78	0.64	-0.96	0.64
24	1	1	2	5	4	2	1	1	3	3	-1.47	1.05	-1.14	0.65	-1.22	0.55

Table L.1 Raw Data (Continued)

Number	Shcool	Group	Gender	Faed	Moed	Room	Comp	Net	PREACH	POSTACH	HOMER	PARED	PRESUCC	PREENJY	POSTSUCC	POSTENJY
25	1	2	1	3	4	1	1	1	8	11	-2.10	-0.16	-0.17	1.04	-0.26	1.02
26	1	2	1	2	2	1	1	1	3	3	-1.80	-1.45	-2.71	-0.80	-1.82	-0.59
27	1	2	2	4	4	2	1	1	6	7	-1.45	0.63	-2.52	-2.30	-2.22	-2.63
28	1	2	1	3	1	1	2	1	6	4	-0.52	-1.94	-1.06	-0.88	-1.38	-0.20
29	1	2	1	2	2	2	2	2	5	7	1.03	-1.63	1.18	0.55	1.17	0.49
30	1	2	1	4	2	2	2	2	5	8	0.97	-0.78	0.16	0.72	0.10	0.67
31	1	2	1	4	2	1	2	1	5	16	-0.69	-1.08	0.44	0.60	0.55	0.65
32	1	2	1	6	6	2	2	2	3	12	0.36	1.79	0.56	0.75	0.55	0.65
33	1	2	2	5	4	2	2	2	5	9	0.67	0.50	1.18	0.55	1.17	0.49
34	1	2	1	4	3	2	2	2	6	7	0.83	-0.35	0.49	0.04	0.17	0.50
35	1	2	1	4	4	2	2	2	4	8	0.70	0.08	1.18	0.55	1.17	0.49
36	1	2	1	2	2	1	2	2	8	10	0.34	-2.00	-0.28	0.62	-0.26	1.02
37	1	2	2	3	2	2	2	1	7	6	0.02	-1.13	0.56	0.75	0.55	0.65
38	1	2	1	6	4	2	2	2	7	10	0.64	0.92	0.72	0.53	0.66	0.45
39	1	2	2	5	4	2	2	2	6	7	0.67	0.50	0.77	0.27	0.78	0.15
40	1	2	1	5	2	2	2	2	4	7	0.94	-0.36	0.42	-0.31	0.08	0.17
41	1	2	1	6	6	2	2	2	8	13	0.36	1.79	0.56	0.75	0.55	0.65
42	1	2	1	5	5	1	1	1	6	5	-2.30	1.12	-1.34	0.36	-0.94	0.18
43	1	2	1	4	4	1	1	1	3	2	-2.13	0.26	0.28	0.35	0.15	0.40
44	1	2	2	3	3	2	2	2	7	9	0.86	-0.77	-0.57	1.01	-0.71	1.04
45	1	2	1	5	3	2	2	2	6	9	0.81	0.07	0.34	0.42	0.18	0.52
46	1	2	2	2	1	1	2	2	3	6	0.48	-2.43	0.59	-0.91	1.02	-1.03
47	1	2	2	3	3	2	1	2	4	4	-0.30	-0.30	0.16	-2.70	-0.21	-2.37
48	1	2	1	6	4	2	2	2	3	4	0.64	0.92	-3.48	-2.24	-3.83	-1.74
49	1	2	2	3	3	2	2	2	6	9	0.86	-0.77	0.71	-0.58	0.90	-0.71
50	1	2	1	5	4	2	2	2	9	12	0.67	0.50	-2.54	-0.15	-2.94	-0.04
51	1	2	1	3	3	1	1	1	8	13	-1.96	-0.59	-0.23	0.47	-0.39	0.53
52	1	2	2	5	4	2	1	2	5	15	-0.49	0.98	0.63	-1.24	0.37	-0.90
53	1	2	1	5	4	2	2	2	6	8	0.67	0.50	-0.64	1.02	-0.02	0.67
54	1	2	1	5	4	2	1	2	4	5	-0.49	0.98	-0.30	-0.12	-0.31	-0.43
55	1	2	1	5	4	2	2	2	9	10	0.67	0.50	1.66	-1.43	1.58	-1.48
56	1	2	1	5	6	2	2	2	10	14	0.39	1.37	-0.28	-2.00	-0.42	-1.82
57	1	2	1	3	2	2	2	2	9	11	1.00	-1.21	1.39	-0.71	1.37	-0.81
58	1	2	2	5	4	2	2	2	8	13	0.67	0.50	1.38	-1.34	1.41	-1.53
59	1	2	2	5	5	2	2	2	12	16	0.53	0.94	1.14	0.17	1.09	0.16
60	1	2	2	3	2	1	1	2	9	12	-0.85	-1.10	-0.28	-1.99	-0.66	-1.67
61	1	2	1	4	4	2	2	2	6	8	0.70	0.08	-0.27	-1.03	-0.42	-1.15

Table L.1 Raw Data (Continued)

Number	Shcool	Group	Gender	Faed	Moed	Room	Comp	Net	PREACH	POSTACH	HOMER	PARED	PRESUCC	PREENJY	POSTSUCC	POSTENJY
62	1	2	1	5	5	2	2	2	11	15	0.53	0.94	0.79	-0.94	0.98	-1.07
63	1	2	2	5	5	2	2	2	9	15	0.53	0.94	0.98	-0.82	0.91	-0.72
64	1	2	1	5	4	2	2	2	6	8	0.67	0.50	0.13	-1.96	0.17	-2.07
65	2	2	2	2	2	2	1	2	10	8	-0.13	-1.15	-1.06	-2.28	-1.82	-2.09
66	2	2	2	5	4	2	2	2	6	7	0.67	0.50	0.21	0.88	0.15	0.83
67	2	2	2	5	2	2	2	1	3	6	-0.03	-0.29	1.77	-0.87	1.78	-1.00
68	2	2	2	5	4	2	1	2	5	6	-0.49	0.98	-0.29	-0.40	0.00	-0.69
69	2	2	1	4	1	2	1	1	4	5	-1.03	-0.67	-0.74	-2.16	-0.65	-2.46
70	2	2	1	4	2	2	2	2	6	9	0.97	-0.78	0.21	0.88	0.15	0.83
71	2	2	1	5	2	2	2	2	8	12	0.94	-0.36	0.77	0.27	0.78	0.15
72	2	2	1	5	5	2	2	2	7	13	0.53	0.94	0.77	0.27	0.78	0.15
73	2	2	2	5	5	2	2	2	6	7	0.53	0.94	0.44	0.88	0.76	0.68
74	2	2	2	4	2	2	2	1	6	8	-0.01	-0.71	-0.78	0.64	-0.96	0.64
75	2	1	2	6	5	2	1	1	5	9	-1.64	1.91	-0.28	-1.49	-0.49	-1.28
76	2	1	2	6	4	2	2	2	7	11	0.64	0.92	-2.35	1.30	-1.32	0.99
77	2	1	2	4	4	2	1	1	7	13	-1.45	0.63	-1.31	1.05	-1.47	1.05
78	2	1	1	5	5	2	2	2	4	8	0.53	0.94	0.80	0.71	0.76	0.68
79	2	1	1	3	3	1	1	1	4	7	-1.96	-0.59	-0.07	0.15	-0.21	0.17
80	2	1	1	4	3	2	2	2	8	15	0.83	-0.35	0.49	0.04	0.17	0.50
81	2	1	1	4	4	2	2	2	7	10	0.70	0.08	0.58	0.70	1.17	0.49
82	2	1	1	2	2	1	2	2	5	9	0.34	-2.00	-0.17	1.04	-0.26	1.02
83	2	1	1	3	2	2	2	1	5	8	0.02	-1.13	0.56	0.75	0.55	0.65
84	2	1	1	5	5	1	1	1	7	14	-2.30	1.12	-1.08	0.33	-0.94	0.18
85	3	1	1	4	4	1	1	1	2	8	-2.13	0.26	0.35	-0.34	0.15	0.40
86	3	1	2	3	3	2	2	2	6	12	0.86	-0.77	-0.92	1.13	-0.71	1.04
87	3	1	2	5	3	2	2	2	6	13	0.81	0.07	0.34	0.42	0.18	0.52
88	3	1	2	5	5	2	2	2	9	11	0.53	0.94	0.77	0.27	0.78	0.15
89	3	1	1	5	5	2	2	2	7	9	0.53	0.94	0.80	0.71	0.76	0.68
90	3	1	1	4	2	2	2	1	5	15	-0.01	-0.71	-0.78	0.64	-0.96	0.64
91	3	1	2	3	3	1	1	1	9	14	-1.96	-0.59	-0.23	0.47	-0.39	0.53
92	3	1	2	5	4	2	1	2	5	13	-0.49	0.98	0.47	-0.78	0.37	-0.90
93	3	1	2	5	4	2	2	2	4	8	0.67	0.50	-0.27	0.85	-0.02	0.67
94	3	1	2	4	5	2	2	2	6	6	0.56	0.51	-0.19	0.85	-0.26	1.02
95	3	1	1	2	2	1	1	1	4	3	-1.80	-1.45	0.44	-0.18	0.42	-0.37
96	3	1	1	5	4	2	2	2	2	7	0.67	0.50	-0.88	0.50	-1.04	0.43
97	3	1	1	4	4	2	1	1	8	9	-1.45	0.63	-1.31	1.05	-1.47	1.05
98	3	1	2	5	5	2	2	2	6	14	0.53	0.94	0.80	0.71	0.76	0.68

Table L.1 Raw Data (Continued)

Number	Shcool	Group	Gender	Faed	Moed	Room	Comp	Net	PREACH	POSTACH	HOMER	PARED	PRESUCC	PREENJY	POSTSUCC	POSTENJY
99	3	1	2	3	3	1	1	1	5	15	-1.96	-0.59	0.10	-0.32	-0.21	0.17
100	3	1	2	4	2	2	2	2	8	8	0.97	-0.78	-0.17	1.04	-0.26	1.02
101	3	1	2	5	2	2	2	2	3	9	0.94	-0.36	0.77	0.27	0.78	0.15
102	3	1	2	5	5	2	2	2	5	5	0.53	0.94	1.39	0.07	1.40	-0.01
103	3	2	1	4	2	2	2	2	4	8	0.97	-0.78	0.07	0.50	0.10	0.67
104	3	2	1	4	2	1	2	1	7	5	-0.69	-1.08	0.09	1.01	0.36	0.86
105	3	2	2	2	2	1	1	1	3	3	-1.80	-1.45	-0.17	1.04	-0.26	1.02
106	3	2	1	3	3	2	2	2	3	4	0.86	-0.77	-0.36	0.53	-0.71	1.04
107	3	2	2	5	3	2	2	2	7	9	0.81	0.07	0.34	0.42	0.18	0.52
108	3	2	2	2	1	1	2	2	6	12	0.48	-2.43	1.07	-0.94	1.37	-1.16
109	3	2	2	3	3	2	2	2	9	11	0.86	-0.77	-0.57	1.01	-0.71	1.04
110	3	2	1	5	3	2	2	2	9	15	0.81	0.07	0.34	0.42	0.18	0.52
111	3	2	1	2	1	1	2	2	5	7	0.48	-2.43	0.68	-0.73	0.61	-0.84
112	3	2	1	3	3	2	1	2	3	6	-0.30	-0.30	-0.39	-2.08	-0.21	-2.37
113	3	2	2	5	4	2	1	2	5	10	-0.49	0.98	0.07	-0.75	0.00	-0.69

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Degree	Institution	Year of Graduation
MS METU	SSME	2003
BS METU	Physics Education	2001
High School	Denizli Cumhuriyet Lisesi	1996

WORK EXPERIENCE

Year	Place	Enrollment
2009- Present	-	Comic Artist
2001-2008	METU	Research Assistant

FOREIGN LANGUAGES

Fluent English

PUBLICATIONS

- Berberoğlu, G., Çelebi, Ö., Özdemir, E., Uysal, E., & Yayan, B. (2003) Üçüncü Uluslararası Matematik ve Fen Çalışmasında Türk Öğrencilerin Başarı Düzeylerini Etkileyen Etmenler. *Eğitim Bilimleri ve Uygulama, 2*(3), 3-14.
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HOBBIES

Reading comics, playing flute, riding bicycle, playing computer games.