# THE EFFECTIVENESS OF INSTRUCTIONAL MULTIMEDIA INTEGRATED WITH AUDIO PLAYBACK RATE CONTROL TOOL ON EIGHTH GRADE STUDENTS' ACHIEVEMENTS AND ATTITUDES



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# ABSTRACT

## THE EFFECTIVENESS OF INSTRUCTIONAL MULTIMEDIA INTEGRATED WITH AUDIO PLAYBACK RATE CONTROL TOOL ON EIGHTH GRADE STUDENTS' ACHIEVEMENTS AND ATTITUDES

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This study investigated how the use of instructional multimedia integrated with audio playback rate-control tool affects the eighth grade students' achievement and attitudes. The audio playback rate-control tool used in this study allows audio to be listened in less time or more time than it was originally recorded, with no loss of voice quality or intelligibility. The study also examined students' tendencies in using audio playback rate-control tool used in the instructional software, and explored the opinions of the students toward the instructional software that is supported by audio playback rate-control tool. A quasi-experimental pretest-posttest nonequivalent control group design was used in this study. The study used data from 48 (26 female, 22 male) students of two eight-grade classes of Private Bilim Elementary School in Ankara. In this study, convenient sampling method was used. For the purpose of the present study two versions of instructional software (with and without audio playback rate-control tool) on Simple Machines subject for the eight-grade Science course were developed. Experimental group used the instructional software with the audio playback rate-control tool, and control group used the instructional software without the audio playback rate-control tool. The results of the study indicated that the treatment in both groups improved their achievement scores significantly. However, the results indicated that there is no statistically significant difference between the experimental and the control groups' achievements and attitudes in pre and posttests. The analysis of computer logs and interview results indicated that students used and liked the audio playback rate-control tool.

Keywords: Audio Playback Rate-Control Tool, Computer Assisted Instruction, Instructional Technology, Multimedia Learning, Time-Compressed Audio

## ÖZ

## SES DOSYALARININ ÇALMA HIZINI AYARLAMA ARACI EKLENMİŞ ÇOKLUORTAM ÖĞRENME YAZILIMININ SEKİZİNCİ SINIF ÖĞRENCİLERİNİN BAŞARI VE TUTUMLARINA ETKİSİ

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Bu çalışma ses dosyalarının çalma hızını ayarlama aracı eklenmiş öğrenme amaçlı çoklu ortam yazılımının sekizinci sınıf öğrencilerinin başarı ve tutumlarını nasıl etkilediğini araştırmaktadır. Bu çalışmada kullanılan ses dosyalarının çalma hızını ayarlama aracı orjinal ses dosyasının kayıt edildiği hızdan ses kalitesinde bir kayıp olmadan daha yavaş ya da daha hızlı dinlenebilmesine olanak tanımaktadır. Bu çalışmada aynı zamanda öğrencilerin çoklu ortamdaki ses dosyalarının çalma hızını ayarlama aracını kullanma eğilimleri ve öğrencilerin ses dosyalarının çalma hızını ayarlama aracı eklenmiş çoklu ortam ile ilgili görüş ve önerileri incelenmiştir. Bu çalışmada ön test-son test kontrol ve deney grupları yarı deneysel deseni kullanılmıştır. Veriler Ankara'da bulunan Özel Bilim İlköğretim Okulu'nda öğrenim gören 26'sı kız, 22'si erkek, toplam 48 öğrenciden elde edilmiş ve kolay ulaşılabilir örnekleme yöntemi kullanılmıştır. Bu araştırmada kullanılmak üzere sekizinci sınıf Fen Bilgisi dersi Basit Makineler ünitesini içeren iki farklı (ses dosyalarının çalma hızını ayarlama aracı eklenmiş ve eklenmemiş) öğretim yazılımı geliştirilmiştir. Deneysel grup öğretim yazılımının ses dosyalarının çalma hızını ayarlama aracı eklenmiş uyarlamasını, kontrol grupta eklenmemiş uyarlamasını kullanmıştır. Araştırmanın bulguları her iki gruptaki öğrencilerin başarılarını anlamlı olarak artırdıklarını göstermiştir. Bununla birlikte deneysel ve kontrol grupların başarı ve tutumları arasında istatistisel olarak anlamlı bir fark bulunamamıştır. Bilgisayar günlük kütüklerinden ve görüşmelerden elde edilen bulgular öğrencilerin ses dosyalarının çalma hızını ayarlama aracını kullandıklarını ve beğendiklerini göstermektedir.

Anahtar Kelimeler: Ses Dosyalarının Çalma Hızını Kontrol Etme Aracı, Bilgisayar Destekli Öğretim, Öğretim Teknolojisi, Çokluortam'da Öğrenme, Zamansal Olarak Sıkıştırılmış Ses Dosyası

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# CHAPTER 1

# INTRODUCTION

## 1.1 Background and Rationale for the Study

Developments in technology have made computers more available to educators. The availability of multimedia capabilities such as high quality digitized audio and video on computers has increased the number of instructional multimedia for learning environments. Bates (2000) pointed out that "Well-designed multimedia learning materials can be more effective than traditional classroom methods because students can learn more easily and more quickly through illustration, animation, different structuring of materials, and increased control of and interaction with learning materials" (p. 28). Alessi and Trollip (2001) supported this idea and stated "… many designers and developers believe that just adding multimedia elements makes software more instructionally effective" (p. 5).

International Society for Technology in Education [ISTE] (1998) stated that traditional educational practices no longer provide students with all the necessary skills for economic survival in today's workplace. According to ISTE (1998), effective learning environments should prepare students to:

- Communicate using a variety of media and formats
- Access and exchange information in a variety of ways

- Compile, organize, analyze, and synthesize information
- Draw conclusions and make generalizations based on information gathered
- Use information and select appropriate tools to solve problems
- Know content and be able to locate additional information as needed
- Become self-directed learners
- Collaborate and cooperate in team efforts
- Interact with others in ethical and appropriate ways (pp. 11-12).

"New technologies such as the World Wide Web and multimedia have the potential to widen access to new learners, increase flexibility for 'traditional' students, and improve the quality of teaching by achieving higher levels of learning, such as analysis, synthesis, problem solving, and decision making" (Bates, 2000, p. 1). As Bates mentioned, these new technologies can be designed to develop higher-order learning skills, such as problem solving, decision-making, and critical thinking to prepare students for the needs of today's workplace.

In traditional learning environments, one-to-one teacher-student instruction is not economically feasible. Bates (2000) indicated, "Since the late 1960s, the number of students in public education around the world has steadily expanded" (p.8). Bates also stated that the increase in students causes increases in class size, which result in less individual interaction with teachers and less attention for students. Therefore, as Bates mentioned we "need to do the more with less" (p.8). Computer-assisted instruction (CAI) has the capability to provide individualized instruction with less number of teachers. Hoska (1993) mentioned that CAI is a learning environment that supports a one-to-one interaction between a learner (or several learners) and a computer program. Therefore, CAI has become one of the most important parts of the today's learning environments.

Most of the today's CAI applications include multimedia elements. Multimedia learning environments are different from traditional learning environments. Multimedia makes possible the delivery of information in ways other than traditional lecture and text formats. In traditional learning environments, what information is learned and the way in which this information is presented is controlled by the teacher. In contrast, multimedia-learning environments are characterized by the ability to present information by letting learner to control over his/her own instruction (i.e., learner control) in a nonlinear way. In other words, learner has the opportunity to select what information to access as well as how to sequence the information in a way that is meaningful to him or her. He/she can navigate within the multimedia environment in a way that is unique and individual for him/her.

According to Mayer and Moreno (2000), individualized instruction is based on the fact that different learners need different instruction since students differ in their interests, their speed of learning and their ways of using strategies. Kinsella (1995) said a truly student-centered learning environment would take the diversity of learner differences and learning styles into consideration. A learning style is defined as "an individual's natural, habitual, and preferred ways of absorbing, processing, and retaining new information and skills which persist regardless of teaching methods or content area. Everybody has a learning style, but each person's is as unique as a signature" (Kinsella, 1995, p. 171).

Educators are looking for better ways to use computers within learning environments to minimize the negative effects based on individual differences among learners. For this purpose, many researchers investigate the effectiveness of alternative methods of integrating computers into the instruction such as tutorials, hypermedia, drills, simulations, and educational games. However, integrating computers into the learning environments is not a simple task. The computer by itself does not automatically ensure effective learning. It requires improving the computer software by making them more effective and user friendly. One of the essential features of instructional multimedia is the flexibility of learning that it provides. Multimedia learning environment may provide the individual student a choice of mode of presentation, such as text, pictures, and audio. Moreover, he/she may have control over the order of presentation of the material and of the learning strategies that are employed. In today's world, individuals want the ability to get knowledge and information in the most efficient way. Therefore, today's multimedia learning systems should allow users to see, hear, and interact with instruction and information at their own individual style. In this context, controlling the playback rate of audio in instructional software allows the student to listen audio at his or her own rate by regarding the diversity of learner differences and learning styles.

A technique that enables rate control of audio playback is time-compression. Rate-controlled audio playback allows audio to be listened to in less time (called time-compressed) or more time (called time-expanded) than it was originally recorded. In early studies, time-compressed audio was produced by playing back a recording at a speed faster or slower than the original recording (Harrigan, 1995). While this method is simple to produce, the voice quality and intelligibility were negatively affected. Today, several new methods exist for changing the playback rate of recorded audio. These methods allow listeners to adjust the word per minute (wpm) rate of recorded audio to suit their needs while preserving the quality or intelligibility of audio. Some of the most cited methods are: (a) removing pauses in the audio, (b) removing small chunks of the audio at regular intervals in time, and (c) using the synchronized overlap and add (SOLA) technique (Roucos & Wilgus, 1985). The SOLA method is a selective sampling method. With this method, the beginning of a speech segment is overlapped and averaged with the previous speech segment at the position of highest cross-correlation. The resulting time-compressed file is of very good quality, and there is no significant change in voice quality and intelligibility (Harrigan, 1995).

The pedagogical significance of time-compression lies in the fact that although the average person speaks at 100 to 150 wpm, most of us can comprehend spoken information at the rate of 250 to 300 wpm (Foulke & Sticht, 1967, cited in Fulford, 2001). Numerous researchers have studied the rate of compression and its resulting effect on comprehension. In their most recent research, Omogui, He, Gupta, Grudin, and Sanocki (1999) found that when normal speech is speeded up using compression, a speed of 210 wpm results in no loss of comprehension. Foulke and Sticht (1967, cited in Fulford, 2001) investigated the intelligibility and comprehension of different rates of speech with 100 college students. Their research results demonstrated a 6% loss in comprehension between 225 and 325 wpm, and a loss of 14% between 325 and 425 wpm.

In order to develop effective instructional multimedia, research data are required to see how particular aspects of it affects learners' performance, attitudes and preferences. One of the important aspects of instructional multimedia is sound. Even though there are research studies investigating the comprehension of different speech rates, the literature falls short in how rate controlled audio playback in instructional multimedia affects learners' achievements, attitudes, and preferences. Therefore, there is a need to investigate how learners' achievements, attitudes, and preferences are affected by audio playback rate control attribute in instructional multimedia.

## 1.2 Purpose of the Study

This study has several purposes in relation to the effectiveness of simple machines instructional multimedia, which was specifically developed for this study. First, to investigate the effects of the use of audio playback rate control attribute in instructional multimedia on students' achievements and attitudes. Second, to explore the patterns of students' usage of audio playback rate-control tool. The study also aimed to explore the opinions of the students toward the instructional software that is supported by audio playback rate-control tool.

## 1.3 Significance of the Study

Alessi and Trollip (2001) stated that one of the main principles relevant to perception is "Information (visual and aural) must be easy to receive" (p. 21). They added, "Information presented too quickly or too slowly increases the difficulty of both attention and perception" (p. 21). However, as we know from the literature, "Not all people learn alike or at the same rate" (Alessi & Trollip, 2001, p.30), and every individual have a different learning process (Dillon & Gabbard, 1998; Fitzgerald & Semrau, 1998). This means that the perception or comprehension rates of people changes from person to person. For example, one person may comprehend spoken information at the rate of 250 words per minute and find it as normal rate, but another person may not comprehend that information and find it as 'too quick' or 'too slow'. Alessi and Trollip (2001) mentioned that most of the commercial software available in the market works the same for all users. Changing the rate during playback allows the student to listen at his or her own speed. In addition, he/she may listen familiar material at a high rate, and slow down for material that may require more time for comprehension. Conducting the present study enabled the researcher to evaluate the effectiveness of the instructional multimedia that has audio playback rate-control attribute. It is hoped that this study would clarify whether the audio playback rate-control tool affects students' achievement and attitudes or not, and consequently contribute to the improvement of the tool by making use of the students' suggestions.

Harrigan (1995) stated that listening to time-compressed and time-expanded audio can produce a significant increase in learning efficiency (learning per unit of time) compared to listening at normal speed. However, experimental studies investigating the effectiveness of rate-controlled audio in instructional software are very limited (Harrigan, 1995). Since there are not enough research studies that investigate instructional multimedia integrated with audio playback rate control tool in instructional software development field, the results of this study will make valuable contribution, and fill the gap in the field. Instructional software designers may also use the results of this study and decide whether to integrate such a tool in instructional multimedia materials.

Allowing learners to adjust the rate of audio playback also enhances amount of interactivity and gives learners additional control on multimedia presentation. The level of interactivity or learner control may affect students' attitudes toward computer and learning subject matter. In addition, recent research on learner control has shown signs of significant difference in achievement for learners who perceive they are in control (Schnackenberg & Hilliard, 1998). It is possible that the higher the level of learner/computer interactivity, the more they perceive control and the greater the level of their achievement. Jonassen, Peck, and Wilson (1999) found "...the more directly and interactively we experience things, the more knowledge about it we are likely to construct" (p. 4). Therefore, the results of this study may also contribute the research in the field of learner control and interactivity in instructional multimedia.

## 1.4 Objectives of the Study

The objectives of the study are listed below:

- To develop instructional multimedia presenting Simple Machines subject in science course at elementary school level that allows students to adjust the playback rate of audio.
- To investigate the effectiveness of simple machines instructional multimedia integrated with audio playback rate-control tool on students' achievement and attitudes
- To find out how students use the audio playback rate control tool.
- To explore the opinions of the students toward the instructional multimedia that has audio playback rate-control attribute.

## 1.5 Limitations of the Study

1. This study is limited to only two classes (each consists of 24 students) in one private elementary school in Ankara.
2. Since it takes a long time to develop educational software, only one unit of science course is included in the study. Therefore, the content of the experiment is limited to one unit, and the duration of the treatment is limited to three weeks.
3. Six hours of treatment (two hours for each week) may also be limited in terms of changing attitudes toward the computers and Science course, and toward the media and materials used during the experiment.
4. Validity and reliability of this study is limited to the validity and reliability of the instruments used in the study.
5. Validity and reliability of this study is limited to the honesty of the subjects' responses to the instruments used in the study.

## 1.6 Experimental Validity

According to Best and Kahn (1997), "validity" refers to whether or not you are measuring what you intend to measure. Campbell and Stanley (1966, cited in Best & Kahn, 1997) identified two types of experimental validity, internal validity and external validity. Internal validity refers to whether or not the effects you obtain in your study are due to your independent variable, and not due to some unintended variable (Fraenkel & Wallen, 2000). In other words, if there are alternative explanations to your data then the study does not have internal validity. What is meant by external validity is that, "...the extent to which the variable relationships can be generalized to other settings, other treatment variables, other measurement variables, and other populations" (Best & Kahn, 1997, p. 140).

Internal validity and external validity can be threatened by several factors. However, all possible threats to validity cannot be controlled in any one study since "…there are so many extraneous variables to attempt to control" (Best & Kahn, 1997, p. 141). Campbell and Stanley (1966, cited in Best & Kahn, 1997) identified some of the threats to the validity of designs. The possible threats to internal validity are history, maturation, testing, unstable instrumentation, statistical regression, selection bias, interaction of selection and maturation, experimental mortality, and experimenter bias.

The outcome of the present study can be influenced by events occurring other than part of the experiment (history). In the present study, the possible external events had a similar effect on both experimental and control groups, in this way this threat was controlled. History threat was also controlled by administering the pre and post-tests to both groups at the same time. Maturation of the subjects could be another threat to the internal validity of the study. Maturation refers to physical and mental changes, which occur in the subjects during the experiment. Best and Kahn (1997) stated this threat is best controlled by randomly assigning the treatment groups. In this study, random assignment to control and experimental groups could not be applied as described in the method part of this study. However, the maturation was not threat in the present study since all the subjects were at the same age and socioeconomic backgrounds. In addition, the treatment groups were balanced on gender (11 male and 13 female in both groups). Testing may be yet another factor affecting the internal validity. Testing threat was unlikely in the present study since pre-testing affected both groups equally. Unstable instrumentation threat was also unlikely in the study since instrument decay affected both groups equally, and the same instructor and data collector were used in both experimental and control groups. Experimental mortality was also unlikely in this study since only one subject for each group did not participate all phases of the study. Lastly, no statistical regression threat existed in this study because subjects were not from the gifted classrooms that can yield extreme scores.

Fraenkel and Wallen (2000) identified two main threats (population validity and ecological validity) related to generalizability of the experimental studies in other words external validity. The generalizations of the findings of this study were limited since convenience sampling was utilized in the present study. However, the findings of this study can be generalized to populations having the same characteristics described in the method part of the study. Moreover, the results of the present study can be generalized to classroom settings similar to this study since the treatments and the instruments were utilized in regular classroom settings.

### 1.7 Definition of Terms

In this section, brief explanations for the important terms used within the study are provided in order to assist the reader in understanding the study.

**Audio Playback Rate-Control Tool:** Audios used in the software were produced in five different rates by time compressing or time expanding the original audio file. These rates were, namely very slow (time-expanding original file by 30%), slow (time-expanding original file by 15%), normal (original audio file), fast (time-compressing original file by 15%), and very fast (time-compressing original file by 30%). During the audio playback, instructional multimedia used in the study allowed experimental group's students to change the rate of audio playback by using Audio Playback Rate-Control Tool. This tool is shown in the following figure:

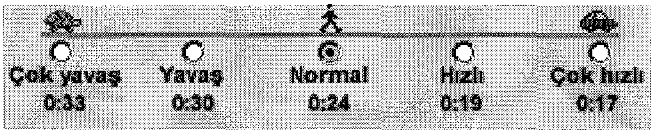


Figure 1.5 Audio playback rate-control tool

**Computer-Assisted Instruction (CAI):** CAI covers a broad category of computer delivered instruction that ranges from tutorial through hypermedia Internet environments (Reeves, 1993).

**Learner Control:** Learner control refers to the selection of content, rate, and sequence including the learner preferences, strategies, and processes used by the learner. "...those design features of CAI that enable learners to choose freely the path, rate, content and nature of feedback in instruction" (Reeves, 1993, p. 40). Learner control appears to be influenced by the learner's perception of his or her control over those design features (Sherman, 1999).

**Locus of Control:** "Locus of control means whether control of sequence, content, methodology, and other instructional factors are determined by the learner, the program (actually the lesson author), or some combination of the two" (Alessi & Trollip, 2001, p. 27).

**Multimedia:** Multimedia is general term that relates to presenting information on a computer. Multimedia has been defined in various ways. Most often, multimedia refers to the integration of media such as text, sound, graphics, animation, video, imaging, and spatial modeling into a computer system (von Wodtke, 1993). Villamil and Molina (1996) define multimedia in two levels. On one level, the word multimedia refers to the integration of multiple media—such as visual imagery, text, video, sound, and animation—which together can multiply the impact of the message. On another level, interactive multimedia refers to the user's ability to control these components and interact with them as needed. Looking at it from a more psychological point of view, multimedia could also be defined as a combination of information presented to different senses (like seeing, hearing, touching) that can be actively influenced by the user (Kozma, 1994).

**Program Control:** Learner control is contrasted with program control, i.e., design features that determine the path, rate, content, and feedback in instruction for learners is called program control.

**Rate-Controlled Audio Playback:** Rate-controlled audio is the audio that is played back in more time (called time-expanded) or less time (called time-compressed) than it was originally recorded.

**Simple Machines:** A machine is any device that can take applied mechanical energy at one point and deliver it in a more useful form at another point. Machines do not reduce the amount of work for us, in fact they increase the amount of work, but they can make it easier by reducing the force required. There are seven types of simple machines which form the basis for all mechanical machines today: levers, wheels and axles, pulleys, gears, inclined planes, wedges, and screws.

# CHAPTER 2

# REVIEW OF THE LITERATURE

This chapter provides a review of the related literature to this study, and focuses on the following areas in the study: computer-assisted instruction, learner control, audio in interactive multimedia, and research studies on rate-controlled audio.

## 2.1 Computer-Assisted Instruction

The computer has become a powerful multimedia/hypermedia device with the arrival of the videodisc, CD-ROM, and digitized video and audio (Merrill, Hammons, Vincent, Christensen, & Tolman, 1996). These technologies and the Internet have opened up new ways to deliver education and training by making possible the delivery of information in ways other than traditional lecture and text formats.

Educational use of computers began in the late 1950s when Stanford University teamed with IBM to offer computer-assisted instruction (CAI) in elementary schools (Horton, 2000). Alessi and Trollip (2001) stated that most of the early CAI consisted of drill and practice sessions and required expensive large mainframe computers. During the 1960s and 1970s, a particularly widespread and influential source of computer-assisted instruction was the University of Illinois' PLATO system (Alessi & Trollip, 2001). PLATO stands for Programmed Logic for Automatic Teaching Operations, and it provided programming environments for computer-based instruction. Horton (2000) indicated that, by 1985, "over 100 PLATO systems were in US, and learners had logged 40 millions hours of instruction" (p. 4).

The computer's use in educational settings has increased dramatically since the last decade since there is a common belief that computers and multimedia have many benefits on teaching and learning. Erickson and Curl (1972) stated that these technologies may play seven basic roles in helping teachers to arrange more effective environments for learning. They stated these roles as follows:

1. They provide the teacher with a means for extending his students' horizon of experience.
2. They help the teacher provide his students with meaningful sources of information.
3. They provide the teacher with interest-compelling springboards, which can launch students into a wide variety of learning activities.
4. They multiply teacher efficiency by providing tutorial stimuli and response guidance for individual students and small groups.
5. They help the teacher to overcome physical difficulties of presenting subject matter.
6. They offer rich opportunities for students to develop communication skills while actively engaged in solving meaningful problems.
7. They provide the teacher with tools to carry out diagnostic testing, research, and remedial work (p. 6).

As stated by Erickson and Curl (1972), computers and multimedia have many benefits in learning environments and can be used in various ways in the educational process. They may be used as a stand-alone educational module that is intended to enable an individual learner to learn about a particular topic or subject, they may be used as a supplement to classroom presentations or they may be used as a dynamic interactive textbook.

Integration of media and technology in the learning environments has changed the roles of the instructor and the learner. With interactive multimedia the control of learning shifts from instructor to learner. Learner transforms from passive recipients of information to active participants in a media-rich learning process. Bruntlett (1999) stated that teacher becomes a resource manager and facilitator rather than the "fount of all knowledge and wisdom" (p. 71). Erickson and Curl (1972) emphasized that "…rather than being a dispenser of facts and retriever of information, the teacher finds it much more challenging, satisfying, interesting, and productive to be the creator and manager of a stimulating learning environment" (p. 6).

Jean Piaget (1954), one of the most influential proponents of constructivist theories, held the view that, learning proceeds through assimilation (relating new information and experiences to existing information and experiences) and accommodation (modifying one's understandings on the basis of new insights and information). He asserts that knowledge is not simply transmitted from teacher to student, but rather is actively constructed in the mind of the learner. According to the constructivist perspective, learning is an active, goal-directed information exploration and learners create their own interpretations of the information. Therefore, learning strategies should be determined by learners' needs, not by the teacher's beliefs and preferences. The constructivist instructional model asserts that learning occurs most effectively when the student is engaged in authentic tasks that relate to meaningful contexts.

Multimedia provides audiovisual support to "help students develop mental models of knowledge they are intended to learn" (Mayer & Moreno, 2002, p.109). Students become more involved and motivated because they find the graphics, animations, simulations and other devices available in multimedia authentic and interesting. In addition, multimedia-learning systems allow users to see, hear, and interact with instruction and information at their own pace. Learners can repeat or revisit realistic scenarios as often as they like. Through these multimedia advantages, a constructivist instructional model advances to higher-level instruction, such as problem solving and increased learner control.

Most of the promises computer-assisted instruction offer are based on the general assumption that the more stimulation, and the more media is involved, the easier it is to learn. In a learning context, the claim is the higher the level of interactivity the more successful will be the learning experience. Hapeshi and Jones (1992) described the effectiveness statements of the British Audio-Visual Society. Hapeshi and Jones (1992) stated the data published by the British Audio-Visual Society as:

An average student can remember:

10% of what is read
20% of what is heard
30% of what is seen
50% of what is seen and heard at the same time
80% of what is spoken
90% of what is spoken and performed at the same time

The evidence for these statements has not been scientifically proved yet, but as the use of computer technologies become more widespread, effects of computer-assisted instruction on teaching and learning process has been the subject of many researches over the past years. The following table, reported in the March 1992 edition of the Multimedia and Videodisc Monitor, represents a summary of key data from six studies (Adams, 1992). In each case, a given course was introduced in both interactive video instruction and traditional classroom formats. Course contents included both soft skills and hard skills training. Findings were in favor of interactive video instruction as shown in Table 2.1:

Table 2.1 Interactive videodisc vs. classroom instruction

| | |
|---|---|
| Learning Curve | 60% Faster |
| Content Retention | 25-50% More |
| Learning Gains | 50-60% Higher |
| Reaching Mastery Level | 50-60% Greater |

In their meta-analysis Kulik, Bangert, and Williams (1983) examined 51 separate evaluations of CAI in grades 6 through 12. The 51 studies covered instruction in a variety of subject areas. In this meta-analysis, findings were summarized as following:

> Computer-based teaching raised students' scores on final examinations by approximately .32 standard deviations or from the $50^{th}$ to the $63^{rd}$ percentile. Computer-based instruction also had smaller, positive effects on scores on follow-up examinations given to students several months after the completion of instruction. In addition, students who were taught on computers developed very positive attitudes toward the computer and positive attitudes toward the courses they were taking. Finally, the computer reduced substantially the amount of time that students need for learning (p. 19).

In a supporting study, Askar *et al.* (1992) conducted a study on students' perception of computer-assisted instruction environment and their attitudes towards computer assisted learning. The subjects were 137 fifth grade students from two private elementary schools. Askar *et al.* (1992) stated that all assessed perceptions of both the computer assisted and traditional environments are in favor of computer assisted learning.

James Kulik's (1994) another meta-analysis examined 500 individual research studies of computer-based instruction. This study yielded both positive and negative findings. The findings of study were as follows:

- On average, students who used computer-based instruction scored at the 64$^{th}$ percentile on tests of achievement compared to students in control conditions without computers who scored at the 50$^{th}$ percentile.
- Students learn more in less time when they receive computer-based instruction.
- Students like their classes more and develop more positive attitudes when their classes include computer-based instruction.
- Computers did not have positive effects in every area in which they were studied.

The Software Publishers Association (1994) reviewed the effect of instructional technologies in 133 research studies from 1990 to 1994. They stated that there were better test results, an increase in self-reliance, and a closer interaction between students and teachers. Thus, instructional technologies could help people to enhance communication, motivation, and self-efficacy.

In his most recent review of computer-based instruction researches, Sivin-Kachala (1998) reviewed 219 research studies from 1990 to 1997 to assess the effect of technology on learning and achievement across all learning domains and all ages of learners. From his analysis of these individual studies he reported the following conclusions:

- Students in technology rich environments experienced positive effects on achievement in all major subject areas.
- Students in technology rich environments showed increased achievement in preschool through higher education for both regular and special needs children.
- Students' attitudes toward learning and their own self-concept improved consistently when computers were used for instruction.
- The level of effectiveness of educational technology is influenced by the specific student population, the software design, the educator's role, and the level of student access to the technology.

In many studies no significant results were found when comparing CAI with traditional classroom instruction. In the literature, it is called "No Significant Difference Phenomenon"*. Russell (2003) has provided summaries of 355 research reports and papers from 1928 to 2002, which yielded no significant difference in learning effectiveness between technology-based and traditional delivery media. Supporting these studies, Clark (1994) stated that media would never influence learning outcomes. Rather, "…learning is caused by the instructional methods embedded in the media presentation" (Clark, 1994, p. 23).

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* See http://teleeducation.nb.ca/nosignificantdifference

The most supported finding in the research literature is that the use of CAI as a supplement to traditional, teacher-directed instruction produces achievement effects superior to those obtained with traditional instruction alone. As summarized in Stennett's (1985) review of reviews, "well-designed and implemented D&P [drill-and practice] or tutorial CAI, used as a supplement to traditional instruction, produces an educationally significant improvement in students' final examination achievement" (p. 7). This finding is consistent with a conclusion drawn by Dalton and Hannafin (1988), "While both traditional and computer-based delivery systems have valuable roles in supporting instruction, they are of greatest value when complementing one another" (p. 32).

**Summary**

As well as enabling students to achieve at higher levels at substantially reduced amount of time for learning, CAI enhances attitude toward instruction and students' perception. Although the figures may differ from study to study and there could be some novelty effects of computers on early research studies such as the Kulik's (1983) study, the conclusion remains the same –learning and retention increase, as the learner is more involved. Many people warn of the possible harmful effects of using computers in the classroom. Will children lose their ability to relate to other human beings? Will they become dependent on technology to learn? Will they find inappropriate materials? The same was probably said with the invention of the printing press, radio, and television. All of these can be used inappropriately, but appropriately used –interactively and with guidance– they have become tools for providing challenging learning environments.

## 2.2 Learner Control

The most important function in educational software is presentation to the user. In most educational software, the dialogue with the student is displayed visually on a screen. The visual presentation can be improved by the use of audiovisual material related to the subject matter. This material may be controlled by the system or manually by the student.

In multimedia instruction, control refers to the selection of content and sequence, but may also include the full range of learner preferences, strategies, and processes used by the learner (Schwier, 1995). According to Reeves (1993), learner control includes "those design features of computer-based instruction (CBI) that enable learners to choose freely the path, rate, content, and nature of feedback in instruction" (p. 40). Williams (1996) stated that regardless of the instructional delivery system employed, control relates to occasions when learners make their own decisions regarding some aspect of path, flow, and events of instruction. Conversely, program control via instructional design controls the path, rate, nature of feedback, content, and events in instruction (Reeves, 1993; Willliams, 1996).

Alessi (1991) categorized learner control into four levels. Each level increases the amount of control given the learner. The first level, program, controls the sequence, content, context, and degree of interactivity, but allows some simple learner control such as forward and backward movement. The second level, adaptive, combines program and learner control. The program adapts to the learner's correct performance by giving over more control. The third level, advisement, gives the learner control with the use of help buttons or advisement from the program. In the fourth level, student, the learner is given the highest degree of control without instruction or feedback. The learner explores within CAI without direction or purpose.

Learner control has been the subject of much research over the past few years. It is interesting that the research results on learner control have not always shown significant positive benefits in achievement scores or attitude. Learners do not always make good decisions when given choices on the computer (Hannafin & Phillips, 1987). Santiago and Okey (1990) stated, giving the learner control may increase motivation to learn but it does not necessarily increase achievement and may increase time-spent learning (cited in Schwier, 1995). One problem may be that giving the controls over instruction may permit them to make poor decisions about which content is important and how much practice is required, which may in turn be reflected in decremented performance (Coldevin, Tovar & Brauer, 1993).

Each individual level of learner control may have a unique influence on learners of different styles. Santiago and Okey (1990, cited in Schwier, 1995) found learners with a high internal locus of control (LOC) increased achievement significantly over learners with high external LOC when using CAI with learner control. They suggest learner control will have different effects on learners of different styles.

In a supporting study, Friend and Cole (1990) reviewed the literature on learner control in CAI and found that the different aspects of learner control affected learners based on their preferences or cognitive styles. Further, they recommended that examining the different levels of learner control and their effects would give valuable information in designing individualized instruction. They matched what they called “styles” of learner control to cognitive learning styles and looked at those results. Their working definition of learner control includes the control of lesson pace, sequence, content, and feedback (Friend & Cole, 1990).

Becker and Dwyer's (1994) study investigated the impact of increased learner control on students' intrinsic motivation for a learning task. The participants of the study, 44 students majoring in accounting, management, or in both completed two self-paced sessions in which they used two multimedia programs. The multimedia programs allowed learners to choose their own paths. The study found that students who used hypertext programs were more self-determined and their intrinsic motivation was higher than those students who used paper-based resources to study.

Gray (1987) found control over sequencing choices resulted in higher achievement but a more negative attitude towards CAI. Gray suggests too much control for the learner may be a distraction causing complex decision-making that interferes with the focus of the lesson and learner. This aspect of learner control is researched by Rogers and Erickson (1998) who found learners suffered when in a hypermedia lesson from cognitive overload when given too much learner control over navigation decisions. This resulted in a “lost in cyberspace” condition (p. 346).

Increased amounts of learner control may not benefit the learner who makes poor choices. Alessi and Trollip (1991) suggested varying the amount of student control based on the “...educational level of the student and lesson complexity” (p. 24). High ability learners usually fare well with learner or program control, but low ability or novice learners suffer from too much learner control (Lawless & Brown, 1997).

Some studies did not find varying the amounts of learner control affects achievement or attitude. In a qualitative study of twenty students using HyperCard, Cho (1995) found no significant difference in his learners' cognitive processes of information seeking and knowledge acquisition when comparing learner control to program control. Cho triangulated statistical analysis with supporting evidence from the qualitative data. He found low ability students processed less information when given increased learner control.

However, Schnackenberg and Hilliard (1998) proposed that measurements of learner control used in previous studies are invalid as they are predicted by a pretest and posttest design. In reviewing studies that used standardized test scores to set an initial achievement level, Schnackenberg found significant difference in achievement in learners who used learner control. "... both higher-and lower-ability students using learner control often outperformed students under program control" (Schnackenberg & Hilliard, 1998, p. 354). They recommend revisiting the issue of when and how to include learner control in CAI.

**Summary**

Learner control has received a great deal of attention from researchers because some of the results suggested the amount of learner control used in instruction could affect achievement and attitude. Some studies show increased learner control results in improved achievement scores. Other studies show different learning styles may respond differently to amounts of learner control. Finally, there are studies that suggest low ability students may suffer from too much learner control while high ability students improve achievement. Too much choice in decision-making may negatively affect the attitude of the learners regardless of ability levels. Thus, this literature review shows that there is no consistency in the way learner control influences students' motivation and attitudes toward learning.

### 2.3 Audio in Interactive Multimedia

Multimedia instruction can be defined as educational programs integrating media elements (text, graphics, animation, sound, or video) in an interactive environment controlled by a computer or similar processor (Barron, Orwig, Ivers & Lilavois, 2002). Instructional materials delivered via a computer date back to the late 1950s when Stanford University teamed with IBM to offer computer-assisted instruction (CAI) in elementary schools (Horton, 2000). At that time, audio was not a part of the instruction.

Although it was possible to digitize audio and incorporate it into computer programs in the 1980s, it was not practical. The primary limitation was the storage requirements. One minute of digitized audio can consume several megabytes of storage if it is stored in high quality (44.1 kHz), 16-bit, stereo format (Barron *et al.*, 2002). Finally, in the early 1990s, the arrival of large hard drives and compact discs, along with improved, standardized compression techniques and formats, created an environment where incorporating audio into multimedia was feasible, easy, and relatively inexpensive (Barron & Varnadoe, 1992).

Audio resources fall into the categories of speech, sound, and music. In general, interface design guidelines identify three main uses of audio in instructional software: (a) to alert learners to errors; (b) to provide stand-alone examples (such as musical passages or digitized versions of speeches); or (c) to narrate text on the screen (Bishop & Cates, 2001). As digital audio became feasible and interactive media tools became more widely used in educational settings, much research has been conducted to investigate the effectiveness of different media within multimedia learning materials. Most of the researches in the literature are based on the dual coding theory and cognitive load theory. These theories provide important theoretical guidance to multi-channel instruction.

*Dual Coding Theory*

"Dual coding theory suggests that learning is enhanced when complementary information codes are received simultaneously" (Alessi & Trollip, 2001, p. 22). In other words, using more than one code simultaneously in the learning process is referred to as dual coding. Bagui (1998) stated "Learning is better when information is referentially processed through two channels than when the information is processed through only one channel" (p. 7). Several studies have been conducted to investigate the effectiveness of the combination of different channels within multimedia learning materials.

Shih and Alessi (1996) compared three treatments (text; voice; text and voice) for 141 college undergraduates. They included two different types of information (spatial vs. temporal). The results did not show any significant differences between groups or any significant interactions among treatment groups and type of learning. However, eighty-two percent of the students reported that they preferred the combination of text and voice to the other methods of delivery.

Quealy and Langan-Fox (1998) conducted a study that involved 60 adults in three treatments: (a) stills (graphic/text screens); (b) audio (graphic/text screens with audio) and (c) video (video/text screens with audio). The results showed no significant group effect for recall.

Another study investigated effects of adding sound to the textual definitions on learning in a hypertext dictionary environment (Tripp & Roby, 1994). It was hypothesized that the encoding of two modalities would result in better retrieval of vocabulary. The results, however, indicated that the audio resources did not have a significant effect on retention.

*Cognitive Load Theory*

In addition to these studies, the cognitive load theory also provides important theoretical guidance to multimedia instruction. Basically, cognitive load refers to the limitations of working memory. Wundt (1897, cited in Bishop & Cates, 2001) found that short-term memory is of limited capacity. There is a limit to the amount of information, or maximal cognitive load, an individual can process in short term memory at any given time. Information that exceeds cognitive processing capacity is dropped from short-term memory without being processed. Therefore, designers should seek to reduce working memory load. Galitz (2002), in contrast, states that long-term memory is theoretically unlimited and consists of hierarchically organized schemas. "Schemas allow us not only to store learned information in long-term memory but, because multiple elements of information are treated as a single element in working memory, schemas also reduce the burden on working memory" (Kalyuga, Chandler, & Sweller, 1999, p. 351).

Mousavi, Low, and Sweller (1995) stated, "the effective size of working memory may be increased by presenting information in a mixed (auditory and visual mode) rather than in a single mode" (p. 320). In this manner, there would be an increase in the capacity of working memory, thereby allowing an increase in the amount of information that could be processed (Kalyuga, Chandler, & Sweller, 1999).

**Summary**

Audio is a major component of many multimedia programs, and instructional designers have many design choices about how the audio elements should be implemented. The design decisions are complex because other media elements, the content, and learners' characteristics must be considered. Based on research studies, it seems clear that effectiveness of different media within multimedia learning materials has produced no firm evidence on the question of whether speech or text is more effective pedagogically, but users show a clear preference for a combination of text and speech (Barron & Atkins, 1993).

## 2.4 Research Studies on Rate-Controlled Audio

In today's world, it is desirable for an individual to be able to acquire knowledge and information in the most efficient way. Technology has provided a medium of altering recorded speech that allows listeners to adjust the words per minute (wpm) rate of recorded audio to suit their needs. Rate-controlled audio playback allows audio to be listened to in less time (called time-compressed) or more time (called time-expanded) than it was originally recorded, with no loss of voice quality or intelligibility.

In early studies, time-compressed speech was produced by playing back a recording at a speed faster or slower than the original recording. While this method is simple to produce, the voice quality and intelligibility were affected. Today, several techniques exist for time-compressing audio with no loss of voice or sound quality or intelligibility. Some of the most cited methods are: (a) removing pauses in the speech, (b) removing small chunks of the speech at regular intervals in time, and (c) using the synchronized overlap and add (SOLA) technique (Roucos and Wilgus, 1985). The SOLA method is a selective sampling method. With this method, the beginning of a speech segment is overlapped and averaged with the previous speech segment at the position of highest cross-correlation. The resulting time-compressed file is of very good quality, and there is no significant change in pitch (Harrigan, 1995). Harrigan (1995) states that this technique produces the best quality speech of all the methods.

The pedagogical significance of rate-controlled audio playback lies in the fact that although the average persons speaks at 100 to 150 wpm, most of us can comprehend spoken information at the rate of 250 to 300 wpm (Foulke & Sticht, 1967, cited in Fulford, 2001) even the fastest talkers reach a physiological barrier at about 215 wpm (Beasley & Maki, 1976, cited in Omogui *et al.*, 1999). Numerous researchers have studied the rate of compression and its resulting effect on comprehension. In their most recent research, Omogui, *et al.* (1999) found that when normal speech is speeded up using compression, a speed of 210 wpm results in no loss of comprehension. Fairbanks, Guttman, and Miron (1957, cited in Omogui *et al.*, 1999) found little difference in intelligibility of selections compressed to 141, 201, and 282 wpm. Diehl, White, and Burke (1959, cited in

Omogui *et al.*, 1999) determined that listening comprehension was unaffected by changes between 126 and 175 wpm. Foulke and Sticht (1967, cited in Fulford, 2001) testing the intelligibility and comprehension of different rates of speech with 100 college students. Using rates of 225, 275, 325, 375, and 425 wpm, they found intelligibility scores at 93, 91, 89, 85, and 84% respectively. The comprehension scores were 73, 66, 67, 56, and 53% respectively. These results demonstrate a 6% loss in comprehension between 225 and 325 wpm, and a loss of 14% between 325 and 425 wpm.

In addition to these studies, several studies have been conducted to determine which level of time-compression listeners would select, if they were presented with several options. Foulke (1969, cited in Fulford, 2001) found that college students preferred a rate of about 207 wpm (approximately 1.38 the normal rate). In his study, Harrigan (1995) offered time-compressed lectures to students at three distinct speeds (1.0, 1.18, and 1.36 the speed of the original lecture). Results showed that 75% of the time, the students preferred the 1.36 rate lecture. Similarly, Omoigui *et al.* (1999), and Li *et al.* (1999) conducted a study that found comfortable speedup rates at approximately 1.4 the rate of normal speech. He and Gupta (2001) concluded that when people were instructed to assume they were in a hurry, rates of 1.6-1.7 the original speed were acceptable.

Wingfield and Ducharme (1999) conducted a study to investigate possible effects of age and passage difficulty on listening-rate preferences. They found that older adults preferred rates significantly slower than younger adults. Both groups preferred slower rates for difficult passages (as measured by cloze predictability) than for easy passages. The researchers concluded that both age groups were equally effective in their ability to monitor the difficulty and adjust the rate.

Experimental studies investigating the effectiveness of rate-controlled audio in educational software are very limited (Harrigan, 1995). Harrigan made a research titled "Self-paced education with compressed interactive audio learning". This study investigates the implementation of a computer system that allow for the capture and playback of audio and overhead slides from a college lecture. He found learners' preference of using the system at the faster speeds over normal speeds; grades on a posthoc test as significantly higher than the grades of learners who reviewed the lecture using textbooks and their own notes.

**Summary**

Research studies have confirmed that listeners can process information at a much higher rate than normal conversational speech. Time-compressed speech can make listening to recorded speech considerably more efficient. Changing the rate during playback allows the student to listen at his or her own pace, skimming over familiar material at a high rate, slowing down for material that may require more time for comprehension. However, comprehension decreases at very high rates. As would be expected, there is a limit to the extent to which speech can be speeded up and still be comprehended.

# CHAPTER 3

# METHOD

This chapter explains the research questions, hypotheses, overall design of the study, subjects involved in the study, development of data collection instruments, data collection procedures, and data analysis procedures.

## 3.1 Research Questions

Question 1 Is there a significant difference between achievements of experimental group who used instructional multimedia integrated with the audio playback rate control tool and control group who used instructional multimedia without the audio playback rate control tool?

Question 2 Is there a significant difference between experimental and control groups' attitudes toward computers?

Question 3 Is there a significant difference between experimental and control groups' attitudes toward science course?

Question 4 What are the students' tendencies in using audio playback rate-control tool used in the instructional software?

Question 5 What are the experimental group's opinions toward the audio playback rate-control tool used in the instructional software?

## 3.2 Hypotheses

To test the research questions statistically the following null hypotheses were stated as temporary solutions to research questions:

Hypothesis 1 There is no significant difference between experimental and control groups' achievement.

Hypothesis 2 There is no significant difference between experimental and control groups' attitudes toward computers.

Hypothesis 3 There is no significant difference between experimental and control groups' attitudes toward science course.

## 3.3 Design of the Study

This study aimed to investigate how the use of instructional multimedia integrated with audio playback rate-control tool affects the eighth grade students' achievement and attitudes. The study also examined students' tendencies in using audio playback rate-control tool used in the instructional software, and explored the opinions of the students toward the instructional software that is supported by audio playback rate-control tool. A quasi-experimental pretest-posttest nonequivalent control group design was used in this study. Experimental and control groups were two eight-grade classes of Private Bilim Elementary School in Ankara. Experimental group used the instructional software with audio playback rate-control tool, and control group used the instructional software without audio playback rate-control tool. Both experimental and control groups' Science course teachers were the same.

Before the experiment, the students in both groups were given an achievement test that measured prior content knowledge, and attitude tests that measured attitudes toward science course and computers as pretests. In the beginning of each topic, the Science course teacher gave one-hour lecture to introduce the topics in general to both groups. In the remaining two lecture hours for the week, the experimental group used the instructional software with audio playback rate-control tool while the subjects in control group studied the software without audio playback rate-control tool in the computer laboratory. The instructional software used by the experimental group students had a log-system. This computer logs was used to find out how students use the audio playback rate control tool. The treatment continued three weeks. At the end of the treatment, both groups were given the same achievement and attitude tests as posttests. An interview was conducted with the subjects in the experimental group to find out their opinions about the audio playback rate-control tool. Table 3.1 shows the overall design of the study.

Table 3.1 Design of the Study

| **Groups** | **Pretest** | **Introduction (3 weeks)** | **Treatment (3 weeks)** | **Posttest Interview** |
|---|---|---|---|---|
| Control Group | Computer attitude test, Science course attitude test, Achievement test | 1 hour introductory lesson for each topic | Instructional software **without** audio playback rate-control tool | Computer attitude test, Science course attitude test, Achievement test |
| Experimental Group | Computer attitude test, Science course attitude test, Achievement test | 1 hour introductory lesson for each topic | Instructional software **with** audio playback rate-control tool **& Computer log** | Computer attitude test, Science course attitude test, Achievement test **& Interview** |

### 3.4 Subjects of the Study

The subjects of this study were students from two eight-grade classes of Private Bilim Elementary School in Ankara. This was a sample of convenience, since random assignment to experimental and control treatments has not been applied. School administration did not allow such assignment. The researcher also did not have control on subjects' prior achievements. These naturally assembled groups as intact classes had equal number of students in terms of gender in both groups as shown in Table 3.2. The equivalence of the number of students in terms of gender had been assembled by the student registration office while students were registering.

The classes in this study were assigned to experimental or control groups randomly. Each class consisted of 25 students. The total number of subjects who participated in the study was 48. One student for each group did not participate in some of the tests. As a result, a total of 24 students from the control, 24 students from the experimental group participated in all phases of the study. There were two computer laboratories in the school; each had 25 computers with multimedia capabilities (including headphones). Both experimental and control groups' Science course teachers were the same.

Table 3.2 Distributions of Subjects of the Study

| Gender | Experimental Group | Control Group | Total |
|---|---|---|---|
| Male | 11 | 11 | 22 |
| Female | 13 | 13 | 26 |
| **Total** | 24 | 24 | 48 |

## 3.5 Variables of the Study

As figured out in Table 3.3, there are three types of variables in this study: control, independent, and dependent variables. These variables are listed and described below:

Control Variables

1. Students' pretest scores on the experimented unit.
2. Students' pretest scores on attitudes toward computers and science course.

Independent Variables

1. Treatment (presence and absence of audio playback rate-control tool in the instructional software).

Dependent Variables

1. Students' posttest scores on the experimented unit.
2. Students' posttest scores on attitudes toward computers and science course.

Table 3.3 Variables of the Study

| Control Variables | Independent Variables | Dependent Variables |
|---|---|---|
| Pretest scores<br>Pre-attitude scores | Treatment<br>(Presence or absence of audio playback rate-control tool) | Achievement test scores<br>Attitudes toward computers and science course |

## 3.6 Development of the Instructional Software

For this research, two versions of instructional software (with and without audio playback rate-control tool) were developed. During the development of instructional software, the following steps were followed:

*Step 1: Selecting Content*

The content of the instructional software was Simple Machines. The researcher selected this content since it was relevant to the target population; eight grade students in elementary school. Students participating in this study investigated levers, wheels and axles, pulleys, gears, inclined planes, wedges, and screws and their usefulness in everyday life. Most of the content of this software were adapted from a commercial instructional software for elementary school students namely Vitamin®*. Vitamin® was developed based on the Ministry of Education curriculum guideline, and also approved by Ministry of Education. The learning objectives of the unit for students were to be able to:

- Explain how simple machines help us do work.
- Describe the uses of the lever.
- Define a pulley and describe its uses.
- Explain how gears work.
- Identify the wheel and axle as a simple machine.
- Describe the uses of the inclined plane.
- Explain the uses of the wedges and screw.

*Step 2: Designing Interface and Programming*

Development of design interface and programming phase involved concept analysis, determining navigation, storyboarding, designing interface, producing time-compressed/expanded audio files, and programming, stages as described below:

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* For more information, http://www.vitaminciler.com

*i) Concept Mapping*

In order to determine the concepts that form the content, main concepts and sub concepts of simple machines subjects were identified. Then, concept map of the units were constructed (see Appendix B) to clarify the interrelations between those concepts. This stage was important to show each concept and relationship between concepts, and to decrease the time spent on programming stage.

*ii) Determining Navigation*

In the development of multimedia application, there are three basic navigational structures (connections and links among various sections of the application content): linear, nonlinear, and composite of linear and nonlinear (Villamil & Molina, 1996).

1. Linear: The user navigates through the application sequentially. A button type tool or arrow takes the user to the previous/next screen or node of instruction. The program controls the sequence of content and the user controls only a mouse click and the pace of content delivery.

2. Nonlinear: The user navigates through the application content without a prescribed or determined path. Menus are the most common method of nonlinear navigation (Alessi & Trollip, 2001). A menu provides an overview of contents and organization, and hyperlinks are used as a choice of all the nodes of content present in the instructional unit.

3. Composite: This type of navigation is composition of linear and nonlinear navigations. The user navigates through the application freely, but as a default prescribed sequence or linear navigation is imposed.

While designing instructional software used in this study, composite navigation strategy was chosen. This strategy would increase learner control and interactivity within hypermedia format and prevent the users from hypermedia phenomenon known as "getting lost in hyperspace" (Alessi & Trollip, 2001, p. 155). The user can choose instruction in any sequence and control the pace and path of delivery by knowing where he/she is and knowing where he/she wants to go.

*iii) Storyboarding*

Units were then mapped in storyboards. Each unit contained instruction and exercises on the material. Storyboards showed each navigation window on a page it should appear as on computer screen. Each window to be designed was shown on a separate storyboard page. Active keys, the names of linked windows, links, text, visuals, multimedia presentations, and graphics to be used were showed on the storyboard (see Appendix C).

*iv) Designing Interface*

Graphics and images were used to illustrate and explain concepts of the units. These graphics and images were integrated with audio files, which were used to narrate illustrations of graphics and images. This technique was chosen because research indicated that users show a clear preference for a combination of text/picture and speech (Barron & Atkins, 1993).

As well as multimedia presentations, there was also text-based information describing concepts on each screen. In addition, user could click a reading button to get extra information on the concept he/she is studying. The application also provided practice exercises for each concept and their detailed solutions.

The navigation of the application was composite of linear and nonlinear strategies. At the bottom of each screen there was a navigation bar including arrows that takes the learner to the next or previous screen of instruction. This navigation bar provided the title of previous, current, and next screens. However, there was a menu button on the right top of the each screen. It provided hyperlinks to content presented in the instructional unit. This menu allowed the user to navigate through the application content without a prescribed or determined path.

The instructional software used by experimental group included the audio playback rate-control tool. This tool allowed the learner to change rate of playback at any time (see Figure 1.5). If user changes the playback rate, the audio starts to play from the very beginning of the file at selected rate. There were also play and pause buttons to control the audio playback. The pause button simply pauses the audio playback. When in a paused state this button changes to resume. This allows the learner to interrupt the audio and then resume at the exact location.

*v) Producing Time-Compressed/Expanded Audio Files*

The original audio files used in the software were taken from Vitamin®. Audios used in the software were produced in five different rates by time-compressing or time-expanding the original audio files. These rates were, namely very slow (time-expanding original file by 30%), slow (time-expanding original file by 15%), normal (original audio file), fast (time-compressing original file by 15%), and very fast (time-compressing original file by 30%). To create time-compressed/expanded audio files, the software named "DUKES" developed by

Kevin Harrigan (1999)* was used. This software uses SOLA technique described in the Introduction part of this study. Harrigan (1995) states that this technique produces the best quality speech of all the methods.

*vi) Programming*

The instructional software was developed using Macromedia Authorware 6. Two versions of the program were developed corresponding to the two treatment conditions. Both of the versions of software were the same differing only absence/presence of audio playback rate-control tool (see Appendix A).

***Step 3: Revising***

After developing the material, it was given to an instructional technology specialist to be evaluated in terms of instructional design aspects, and two science course teachers to be evaluated in terms of content accuracy. Based on the feedback received from those experts, the material was revised and improved.

## 3.7 Data Collection Instruments

To obtain relevant data for the variables of this study, the following instruments were used.

### 3.7.1 Achievement Test on Simple Machines Unit

Simple Machines achievement test (see Appendix D) contained 15 multiple choice questions that were selected from the questions on the instructor's resource book used in the Private Bilim Elementary School and Vitamin® instructional software. Achievement test was categorized into seven topics, the selection of

* Available at http://temagami.uwaterloo.ca/~cporemba/Kevin/suav.html

which was based on the topics involved in the simple machines subject. There were two questions for each topic in the test.

Two science course teachers at Private Bilim Elementary School examined the content validity of the achievement test. They rated questions as valid or not valid in terms of content accuracy, the accuracy of the correct response, and the appropriateness of the distracters. The reliability coefficient for the Simple Machines Achievement Test was found to be 0.80. In this way, the reliability coefficient displayed 80% of the variance of the total achievement scores were reliable and measurement error of the scale was 20%. This reliability score indicates acceptable reliability of the test according to educational research standards.

### 3.7.2 Computer Attitude Scale

An attitude survey, Computer Attitude Scale (see Appendix E), was used to obtain data about student attitudes toward computers. It was adapted from the Computer Attitude Scale, which was originally developed by Loyd and Gressard (1984), and then translated into Turkish and analyzed by Berberoğlu and Çalıkoğlu (1992). The survey consisted of 40 items rated on a Likert type scale. A score of 1 was given to strongly disagree, and 4 were given to strongly agree for positively worded statements. For negatively worded statements the opposite scores were used. While the possible minimum score got from this survey was 40, the possible maximum score was 160. In this survey, high score shows positive attitudes. Berberoğlu and Çalıkoğlu (1992) found the reliability coefficient for Computer Attitude Scale to be 0.90. In this study, it was found to be 0.95 which displayed

95% of the variance of the total attitude scores was reliable and measurement error of the scale was 5%. This indicates high reliability of the attitude survey.

### 3.7.3 Science Course Attitude Scale

Science Course Attitude Scale (SCAS) was adapted from a Bulut's (1994) study. The SCAS (see Appendix F) was consisting of 24 items and items were rated on a likert-type scale with 1 equaling strongly disagree to 5 equaling strongly agree for positively worded statements. For negatively worded statements the opposite scores were used. This instrument was also reviewed and approved by an instructional design expert. The reliability coefficient for Science Course Attitude Scale was found to be 0.94 which displayed 94% of the variance of the total attitude scores was reliable and measurement error of the scale was 6%.

### 3.7.4 Interview Form

An interview form (see Appendix G) was developed to collect qualitative data on experimental group's opinion about the software and audio playback rate-control tool used during the experiment. The purpose of the interview was to determine students' overall reaction to the software and to determine their satisfaction with the audio playback rate-control tool. Interview questions were reviewed by an expert for clarity of the content.

## 3.8 Procedures of the Study

The data from the subjects were collected in the following manner:

The subjects of this study included two eight-grade classes of a Private Elementary School in Ankara. The classes in this study were selected at random to be experimental group or control group. 24 students from the control group, 24 students from the experimental group participated in all phases of the study. Both experimental and control groups' Science course teachers were the same. Experimental group was thought by the instructional software with audio playback rate-control tool, and control group was thought by the instructional software without audio playback rate-control tool. Before the experiment, the students in both groups were given an achievement test that measured content knowledge, and attitude tests that measured attitudes toward science course and computers as pretests.

Both groups had three hours of Science course instruction each week. In the beginning of each topic of the unit, the Science course teacher gave one-hour lecture to introduce the subject matter in general to both groups. In the remaining two lecture hours for the week, the experimental group used the instructional software with audio playback rate-control tool in the computer laboratory while the subjects in control group used the software without audio playback rate-control tool in the computer laboratory. Individual headphones were used to control the noise factor in the laboratory. The treatment continued three weeks.

The instructional software used by experimental group had a log-system (see Appendix H for a sample log file) to gather data on the students' use of audio rate-control tool. This log-system recorded all nodes visited, all audio playback rates chosen i.e. all actions done by students with start and end times. This way of recording students' program usage allowed the researcher to see students' tendencies in using audio playback rate-control tool.

At the end of the treatment, both groups were given the same achievement and attitude tests as posttests, and an interview was conducted with the subjects in the experimental group to find out their opinions about the audio playback rate-control tool. 24 students from the experimental group were interviewed. The group was interviewed as group of four-five students.

### 3.9 Data Analysis

The total score of each subject for achievement and attitude tests were calculated first. Attitude tests used in this study were Likert-type instruments. A score of 1 was given to strongly disagree, and 4 equaling strongly agree for positively worded statements in Computer Attitude Scale (CAS). For negatively worded statements the opposite scores were used. While the possible minimum score got from CAS could be 40, the possible maximum score was 160. In Science Course Attitude Scale (SCAS), the items were rated on a scale with 1 equaling strongly disagree to 5 equaling strongly agree for positively worded statements. For negatively worded statements the opposite scores were used. The possible minimum score got from SCAS was 24 while the possible maximum score was 120. For both of the attitude tests, high score shows positive attitudes. While calculating achievement scores, a score of 1 was given for every correct answer, and a score of 0 was given for an incorrect answer. The total scores than converted into the scale of 100.

The data collected through the achievement and attitude tests were analyzed through descriptive and inferential statistics by using SPSS statistical package. The level of significance for the statistical analysis of the data in this study was set at

.05. A Mann-Whitney U test was conducted to compare experimental and control groups' achievement and attitude scores. The Mann-Whitney U test is a non-parametric test, which is used to evaluate whether the medians on a test variable differ significantly between two groups (Green, Salkind, & Akey, 2000). Best and Kahn (1997) stated that Mann-Whitney U test is a nonparametric equivalent of the parametric *t* test, in which the means of the two groups are equal, assuming normality of the observations. However, the number of subjects enrolled in this study was not enough to assume normality of the observations. Therefore, the Mann-Whitney U test was used.

The data collected through the computer-logs were recorded in electronic spreadsheets by using MS Excel Spreadsheet program. During the use of instructional software, each student's computer-logs were recorded in a text file on a floppy disk. These text files were then printed out and analyzed by the researcher. During the analysis, the main aim was to see patterns of students' use of audio playback rate-control tool. An analysis of the log-system is shown in results part of this study. The interview data were subjected to content analysis to describe student opinions. For this purpose, students' responses were organized according to the main themes identified for the interview questions. Then, they were interpreted.

# CHAPTER 4

# RESULTS

In this chapter, the results of statistical analyses of the research questions and hypotheses are presented. Statistical analyses of computer logs and the results of the interview are also provided in this chapter.

## 4.1 Results of Statistical Analyses on Hypotheses

The results of statistical analyses on hypotheses are presented in this part. The analyses that are presented here are based on data collected from 48 students in experimental group (used instructional software with audio playback rate-control tool) and control group (used instructional software without audio playback rate-control tool) identified by the same teaching contents and the same instructor delivered in both groups during spring 2002 at Private Bilim Elementary School.

Five research questions guided this study and three null hypotheses were tested using SPSS statistical package. The research questions and their related hypotheses were examined in the following order:

Research Question 1: Is there a significant difference in usage of simple machines instructional multimedia with and without the audio playback rate control tool on experimental group and control group students' achievements?

Research Question 1 was analyzed to determine whether there exists any significant difference between the students used instructional software integrated with audio playback rate-control tool (experimental group) and the students used instructional software without audio playback rate-control tool (control group) in achievement tests scores.

The null hypothesis associated with this research question was the following:

H0: There is no significant difference between experimental and control groups' achievement test scores.

To test null hypothesis, the achievement scores of the two groups were compared for the pretest and posttest using the Mann-Whitney U test. The results are displayed in Table 4.1.

Table 4.1 Mann-Whitney U test results for students' achievement scores.

| **Test** | **Group** | **N** | **Rank Sums** | **Mean Ranks** | **Z** | **2-tailed *p*** |
|---|---|---|---|---|---|---|
| Pretest | Experimental | 24 | 566.50 | 23.60 | -.448 | .654 |
| | Control | 24 | 609.50 | 25.40 | | |
| Posttest | Experimental | 24 | 568.50 | 23,69 | -.405 | .685 |
| | Control | 24 | 607.50 | 25.31 | | |

As it is shown in Table 4.1, in terms of the achievement pretest data, the Mann-Whitney U test revealed no significant median difference ($z$=-.448 and $p$=.654) between the students in experimental and students in control groups' achievement. These findings indicate that the experimental and control groups were not statistically different in terms of knowledge base of Simple Machines prior to the treatment, as tested by the achievement test.

For the posttest, the Mann-Whitney U test also showed that there was no significant difference between the achievements as perceived by students in experimental group and those in control group with $z=-.405$ and $p=.685$ (Table 4.1). Therefore, the null hypothesis was accepted.

Although control group had a higher mean scores than that of experimental group in both pre and post tests, the difference is not statistically significant as proved through the Mann-Whitney U test. The results also show that the treatment in both groups improved the achievement scores of students significantly. Table 4.2 shows the means and standard deviations, and Figure 4.1 and 4.2 show the distributions of the scores for the two groups on both pre and post achievement tests.

Table 4.2 Means and standard deviations of pre and post achievement tests.

| Test | Group | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Pretest | Experimental | 24 | 31.92 | 23.72 |
| | Control | 24 | 34.75 | 25.28 |
| Posttest | Experimental | 24 | 66.17 | 18.36 |
| | Control | 24 | 68.38 | 18.46 |

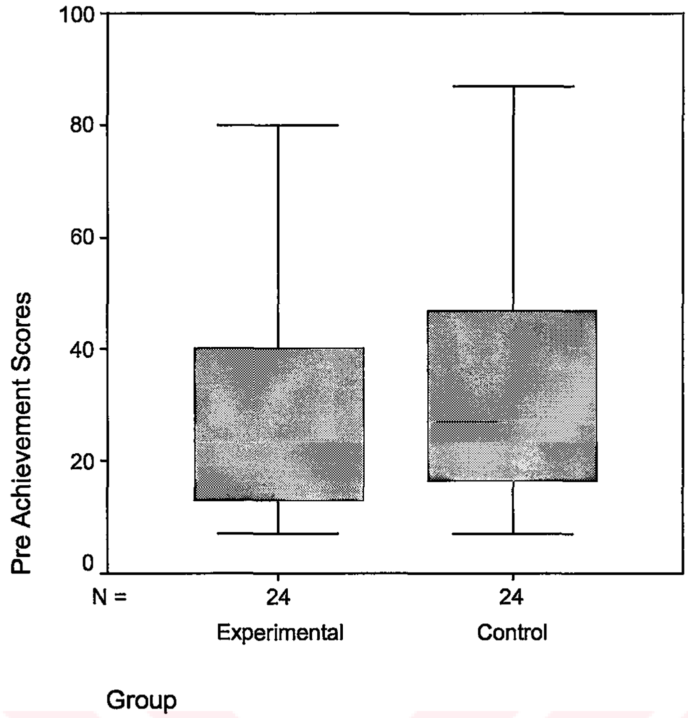


Figure 4.1 The distributions of pre achievement scores for experimental and control groups.

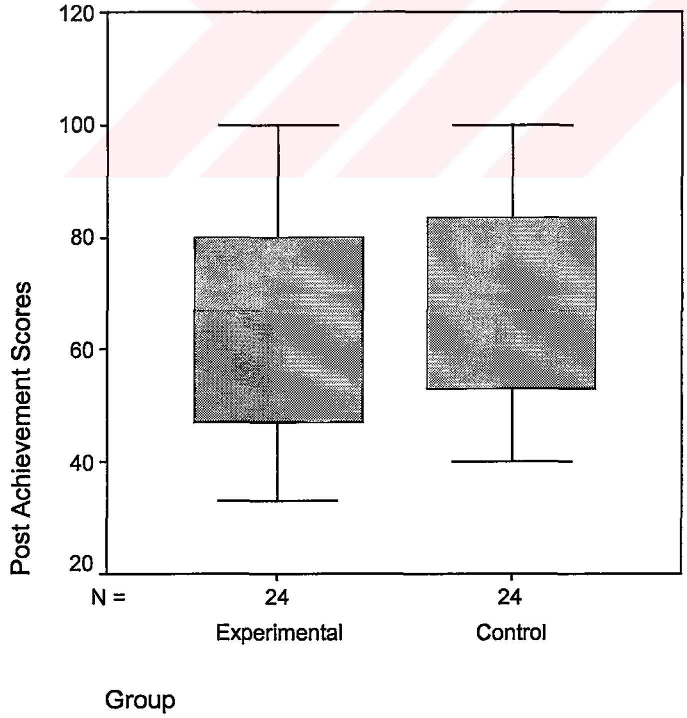


Figure 4.2 The distributions of post achievement scores for experimental and control groups.

Research Question 2: Is there a significant difference between experimental and control groups' attitudes toward computers?

Research Question 2 was analyzed to determine whether differences existed in students' attitudes toward computers with students used instructional software with audio playback rate-control tool as compared with students used instructional software without audio playback rate-control tool.

The null hypothesis associated with this research question was the following:

H0: There is no significant difference between experimental and control groups' computer attitude scale scores.

To test null hypothesis, the computer attitude scale scores of the experimental and control groups were compared for the pretest and posttest using the Mann-Whitney U test. The results are displayed in Table 4.3.

Table 4.3 Mann-Whitney U test results for students' computer attitude scores.

| Test | Group | N | Rank Sums | Mean Ranks | Z | 2-tailed *p* |
|---|---|---|---|---|---|---|
| Pretest | Experimental | 24 | 620.00 | 25.83 | -.660 | .509 |
| | Control | 24 | 556.00 | 23.17 | | |
| Posttest | Experimental | 24 | 632.50 | 26.35 | -.919 | .358 |
| | Control | 24 | 543.50 | 22.65 | | |

In terms of the pretest data, the Mann-Whitney U test revealed no significant median difference ($z$=-.660 and $p$=.509) between the students in experimental and students in control groups' attitudes toward computers. These findings suggest that the experimental and control groups were not statistically different in terms of attitudes toward computers prior to the treatment, as tested by computer attitude scale.

For the posttest, the Mann-Whitney U test showed again no significant difference between the students in experimental and students in control group with $z$=-.919 and $p$=.358. Therefore, the null hypothesis was accepted.

Table 4.4 shows the means and standard deviations and Figure 4.3 and 4.4 show the distributions of the scores for the two groups on both pre and post computer attitude scales.

Table 4.4 Means and standard deviations of computer pre and post attitude scales.

| Test | Group | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Pretest | Experimental | 24 | 132.75 | 16.79 |
| | Control | 24 | 130.79 | 14.41 |
| Posttest | Experimental | 24 | 136.71 | 15.36 |
| | Control | 24 | 133.92 | 13.91 |

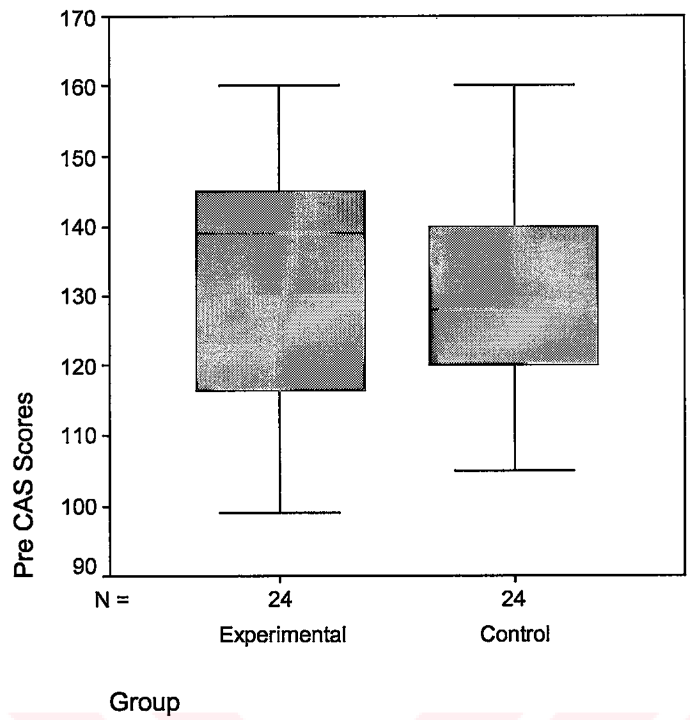


Figure 4.3 The distributions of computer pre attitude scores (CAS) for experimental and control groups.

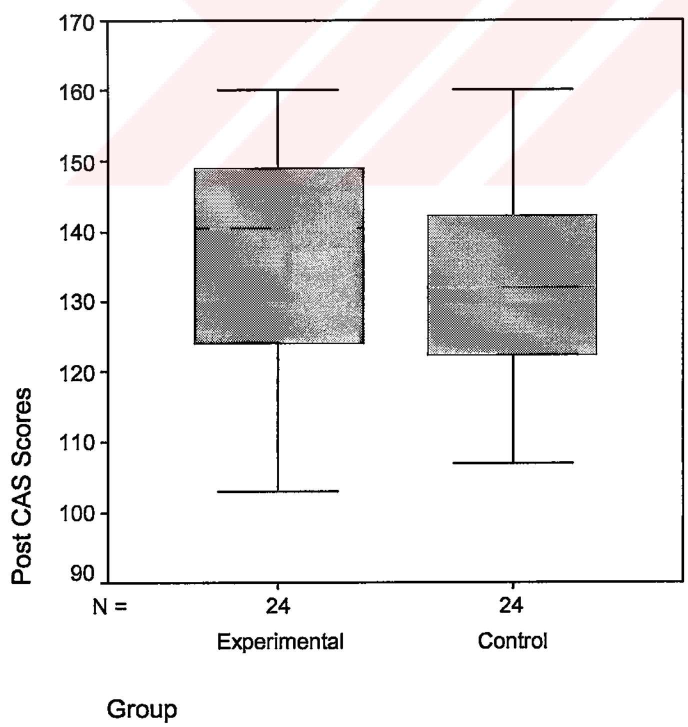


Figure 4.4 The distributions of computer post attitude scores (CAS) for experimental and control groups.

Research Question 3: Is there a significant difference between experimental and control groups' attitudes toward science course?

Research Question 3 was analyzed to determine whether there is any significant difference between control and experimental groups' science course attitude scale scores on posttest.

The null hypothesis associated with this research question was the following:

H0: There is no significant difference between experimental and control groups' medians of science course attitude scale scores.

To test null hypothesis, the science course attitude scale scores of the two groups (experimental and control groups) were compared for the pretest and posttest using the Mann-Whitney U test. The results are displayed in Table 4.5.

Table 4.5 Mann-Whitney U test results for students' science course attitude scores.

| Test | Group | N | Rank Sums | Mean Ranks | Z | 2-tailed *p* |
|---|---|---|---|---|---|---|
| Pretest | Experimental | 24 | 579.50 | 24.15 | -.176 | .861 |
| | Control | 24 | 596.50 | 24.85 | | |
| Posttest | Experimental | 24 | 554.00 | 23.08 | -.703 | .482 |
| | Control | 24 | 622.00 | 25.92 | | |

In terms of the pretest data, the Mann-Whitney U test revealed no significant median difference ($z$=-.176 and $p$=.861) between the students in experimental and students in control groups' attitudes toward the science course. These findings indicate that the experimental and control groups were not statistically different in terms of attitudes toward science course prior to the treatment, as tested by the science course attitude scale.

For the posttest, the Mann-Whitney U test showed again no significant median difference ($z$=-.703 and $p$=.482) between the students in experimental and students in control groups' attitudes toward science course. So, the null hypothesis was accepted. Table 4.6 shows the means and standard deviations, and Figure 4.5 and 4.6 show the distributions of the scores for the two groups on both pre and post science course attitude tests.

Table 4.6 Means and standard deviations of science course pre and post attitude scales.

| Test | Group | N | Mean | Std. Deviation |
|---|---|---|---|---|
| Pretest | Experimental | 24 | 87.00 | 15.77 |
| | Control | 24 | 88.54 | 12.73 |
| Posttest | Experimental | 24 | 90.79 | 13.63 |
| | Control | 24 | 93.17 | 12.87 |

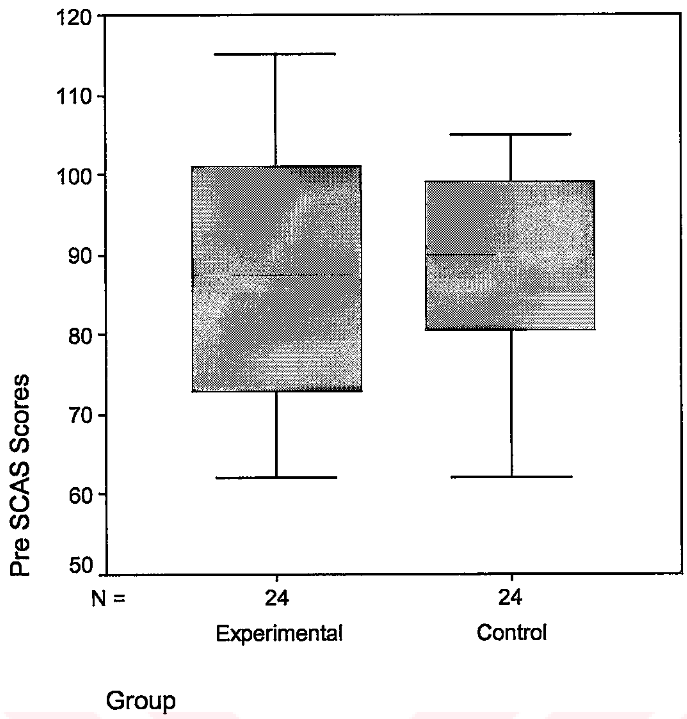


Figure 4.5 The distributions of science course pre attitude scores (SCAS) for experimental and control groups.

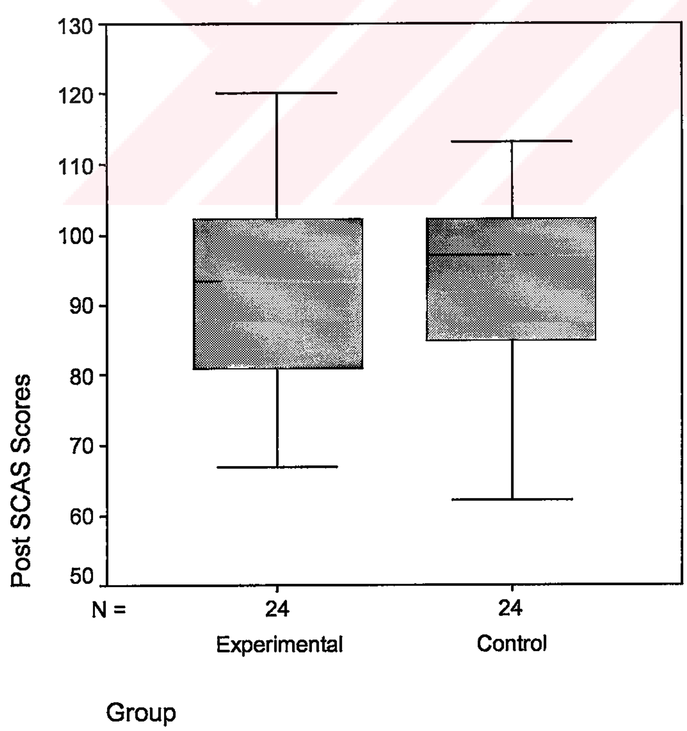


Figure 4.6 The distributions of science course post attitude scores (SCAS) for experimental and control groups.

## 4.2 Results of Statistical Analyses on Computer Logs

Research Question 4: What are the students' tendencies in using audio playback rate-control tool used in the instructional software?

Research Question 4 was asked to investigate the patterns of the students' use of audio playback rate-control tool. Computer logs were used to answer this question. The instructional software had a log-system to gather information about students' tendencies in using audio playback rate-control tool used in the instructional software. This system tracked each student's use of the system and kept a record of start and end times of each option chosen. Because the software has few options, it was easy to analyze the student's use of the software through this log. During the analysis of computer logs, students' listening of audio files for a short period of times was not included into the analysis. The rule was the audio file should be listened totally to be included into the statistical analysis. An example computer log for one student can be seen in Appendix H. An analysis of the students' use of the instructional software is shown in Table 4.7, and percentages of total minutes at five different rates are figured out at Figure 4.7.

Table 4.7 An analysis of the students' use of the audio playback rate-control tool

| Audio playback rate | Total time spent on rate | Percentage (Time spent on rate) | Number of times used | Percentage (# of times used) |
|---|---|---|---|---|
| Normal | 367 min. | 50% | 518 | 47% |
| Very fast | 192 min. | 26% | 370 | 34% |
| Fast | 40 min. | 6% | 68 | 6% |
| Slow | 20 min. | 3% | 22 | 2% |
| Very slow | 111 min. | 15% | 116 | 11% |

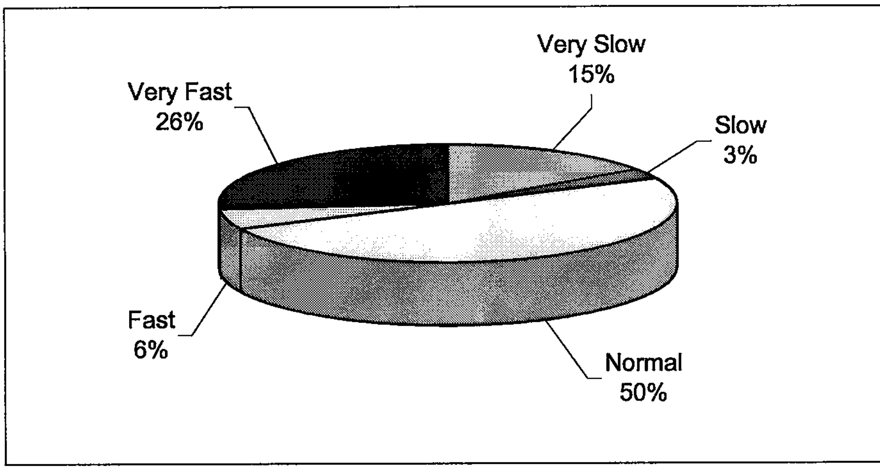


Figure 4.7 Distributions of total time spent on each rate

The normal speed was used 50% of the time, and fastest speed was used 26% of the time. These findings suggest that students mainly used normal speeds, and they liked listening to audio files at the faster speeds. Students also preferred the slowest rate. The slowest rate was used 15% of the time. The most interesting result is that most of the times, students did not prefer slow and fast rates which were middle rates between normal and the slowest, and normal and the fastest rates.

The analysis of computer logs also yielded another result, which points to the distributions of students' first and second listening patterns of the same audio file regarding the playback rates selected by students using the audio playback rate control tool. Table 4.8 shows the students' audio playback rate control tool usage patterns, and Figure 4.8 shows the percentages of students' first and second listening playback rate patterns of the same audio file. The abbreviations in the Figure 4.8 are explained in Table 4.9.

These results were obtained through investigating and coding each student's first and second speed rate pattern choices while listening to the audio files related with all subjects in the instructional media. 16% of the students listened to the audios only once. Among the 16% of the students who listened to the audios only once, 42% of the students listened to the audio files in the normal speed, 32% of the students listened to the audio files in the very fast speed, 18% of the students listened to the audio files in the very slow speed, and the remaining 8% of the students listened to audio files in other speeds.

The remaining 84% of the students listened to the audio files in instructional multimedia more than one time. As provided in the Figure 4.8, among the remaining 84% of the students who listened to the audio files in instructional multimedia more than one time, 34% of the students listened to the same audio file in the normal speed at first and then very fast speed secondly, 23% of the students listened to the same audio file in the normal speed at first and then again normal speed secondly, 16% of the students listened to the same audio file in the normal speed at first and then very slow speed secondly, and the remaining 27% of the students listened to audio files in other patterns.

Table 4.8 Students' audio playback rate control tool usage patterns

| **16% of the students who listened to the audio files only once** | | **84% of the students who listened to the audio files more than one time** | |
|---|---|---|---|
| Normal | 42% | Normal → Very Fast | 34% |
| Very Fast | 32% | Normal → Normal | 23% |
| Very Slow | 18% | Normal → Very Slow | 16% |
| Other rates | 8% | Other patterns | 27% |

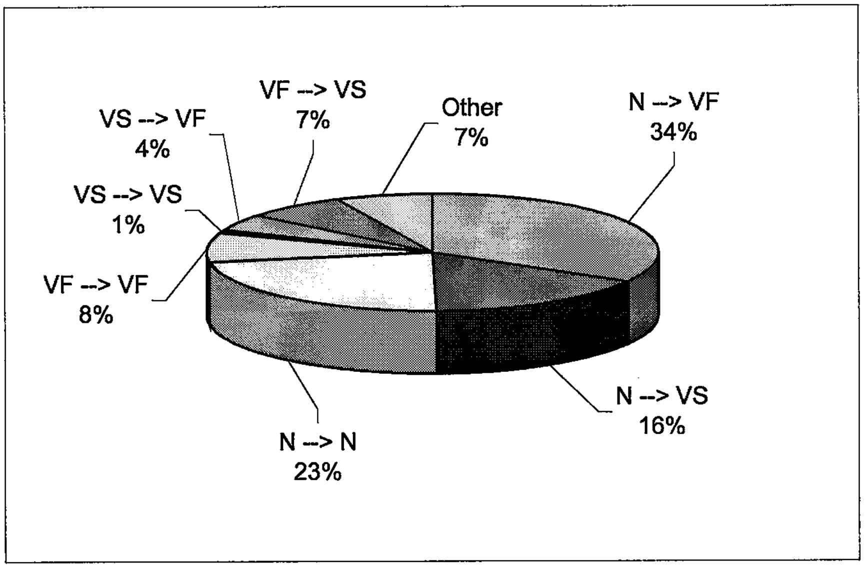


Figure 4.8 Percentages of students' first, second listening patterns of the same audio

Table 4.9 Explanations of abbreviations in the Figure 4.8

| | |
|---|---|
| **N → VF** | First listened to in Normal rate and then listened to in Very Fast rate |
| **N → VS** | First listened to in Normal rate and then listened to in Very Slow rate |
| **N → N** | First listened to in Normal rate and then listened to in Normal rate again |
| **VF → VF** | First listened to in Very Fast rate and then listened to in Very Fast rate again |
| **VS → VS** | First listened to in Very Slow rate and then listened to in Very Slow rate again |
| **VS → VF** | First listened to in Very Slow rate and then listened to in Very Fast rate |
| **VF → VS** | First listened to in Very Fast rate and then listened to in Very Slow rate |
| **Other** | Other patterns not mentioned above |

## 4.3 Interview Results on Students' Opinions About the Instructional Software and the Audio Playback Rate-Control Tool

The qualitative data collected through interview was analyzed to obtain information about the effectiveness of the features of instructional software and audio playback rate-control tool, and to get students' suggestions concerning the improvement of these features. The qualitative data was also used to compare and extend the data collected through the computer logs.

All subjects from the experimental group were interviewed as groups of four-five students. This method was chosen because of time restrictions. While the first three questions were asked to explore students' perceptions of the instructional software, the remaining five questions were asked to explore students' perceptions about the audio playback rate-control tool. The students' responses in Turkish were provided in Appendix H.

### 4.3.1 Student Opinions on the Instructional Software

With the first question, the students' opinions about the instructional software that was used in teaching the simple machines unit in science course were asked.

All of the students (n=24) provided positive feedback about the software. The students stated that they enjoyed the instructional software. 20 of the students stated that it would be better if the science course were supported with computer programs like the one they used during the experiment. For example, one of the students who advocated the advantages of using instructional software stated the following: "Visual presentation of the subject in computer environment helped us understand the subject that were presented in class before easily" [1]. On the other hand, of the remaining four students, one stated that, "I am used to use computers for game purposes. For this reason, I face some problems in getting used to the idea of utilizing computers for educational purposes" [2]. This idea shows that some students see the computer as a game machine or toy. Therefore, it would be helpful to embed some game features into instructional multimedia.

The second and third questions were very interrelated. The purpose of the second question was to gather students' opinions about the positive and negative aspects of the instructional software. With the third question, students' opinions whether the design of the software was appropriate or not to teach simple machine unit were asked.

All of the students (n=24) emphasized the positive aspects of the instructional software, and the students mostly stated that the content itself and the organization of the content together with the detailed explanations whenever needed were appropriate to meet the objectives of the unit. They stated that they found visual representations of each topic and their narrations nice and interesting. One student said, "I found the text and audio-visuals in the software supporting each other. Audio-visual materials were very valuable in drawing my interest and giving me an overall idea about the subject that I was learning" [3]. As another advantage of the software, one of the students stated, "I had the chance of repeating the content as many times as I wanted and this was an advantage of the software when compared with the other methods" [4]. However, one of the students stated, "The software should include more interactive exercises and tests" [5] and the others in the focus group agreed with their friend. They all (n=24) indicated that they did not face any difficulties while using the software. All of them indicated that the software was easy-to-use. They perceived that it was easy to navigate main menu and navigational bar on each window. According to one of the students, providing different navigational tools made him feel more comfortable while using the software. He stated, "I liked and used the menu button frequently because it allowed me jump to the topics in the unit whatever I wanted" [6]. Additionally, another student stated, "I would prefer to use the software when the instructor is around. The reason is that I may need help whenever I face with difficulties in learning the subject matter" [7]. Most of the students (n=20) held the view that they preferred the presence of the teacher while studying in the computer laboratory. Other four students did not care about the presence of the teacher. One of them stated, "The software was providing the necessary information. So I did not need any help from the teacher while using the software. Indeed, while dealing with harder topics, I may also need some help from my teachers" [8]. In general, it can be stated that students' opinions about the instructional software that was used in teaching simple machines unit in science course was very positive.

### 4.3.2 Student Opinions on the Audio Playback Rate-Control Tool

The remaining five questions from fourth to eighth were aimed to gather in depth opinions of the students about the audio playback rate-control tool. These questions were asked in the following order:

With the fourth question the students were asked if they used the audio playback rate-control tool, which was a part of the instructional software, and the reasons of using this tool.

The students mostly (n=22) stated that they used the tool. Only two of them stated that they did not need to use it. These statements were in parallel with the results of the computer logs analysis. The students shared nearly the same opinions while stating their reasons of using the tool. One of the students who used the tool stated, "I used it at 'very fast' rate when repeating the subject matter, which I already know" [9]. Another student stated, "While dealing with difficult subjects such as ‘wheel’, using the ‘very slow’ rate aided me in learning the subject more easily compared with ‘normal’ rate or even the traditional methods through which our teacher explains the subject” [10]. One of the students who did not use the tool stated, “The ‘normal’ rate was the most appropriate to my learning style so I did not need to use the tool”. [11] Additionally, the same student stated, “I found the ‘very slow’ rate too slow and thought that it was time consuming. On the other hand, the ‘very fast’ rate did not help me in learning the topics because I could not catch everything mentioned in the audio file” [12]. Other than these two students, there was a consensus that the ‘very fast’ rate did not create any problems in understanding the narration in the audio file. According to those students, using the ‘very fast’ rate was effective in saving time.

The fifth question was about if the students used the tool, if it contributed to their learning the subject matter, and how it contributed to their learning.

The analyses revealed that students did not express their opinions about the contribution of audio playback rate-control tool to their learning clearly. One of the students stated, “It would be beneficial to integrate such a tool in all instructional software” [13]. The student rationalized his opinion regarding the answers that were provided in the previous interview question. For the previous question, one student provided the following answer: “… while dealing with difficult subjects such as wheel, using the ‘very slow’ rate aided me in learning the subject more easily…” [10]. Another student stated, “The very slow playback rate of audio-videos in the instructional software increased my concentration. If they were fast, I could miss some details. At the same time, since I selected the ‘very slow’ rate, it was possible for me to get the information at once. For this reason, I may claim that I learnt the topics in a shorter time" [14].

The sixth, seventh, and eighth questions were also interrelated. Through these questions students were asked which features of the audio playback rate-control tool they liked most? Why? And which features of the audio playback rate-control tool they did not like? Why? While answering these questions the students also answered the eighth question, asking "What are your suggestions on specific aspects of the tool that may contribute to the improvement of the tool?"

The responses of the students to the sixth question showed that all students (n=24) liked the ease of use of buttons, which allowed them to change the rate of audio playback. One of the students stated, "The design of audio playback rate-control tool was attractive, and easy to use. I didn't face any difficulties while using the tool" [15]. As negative aspects of the tool, one of the students stated, "Starting from the very beginning of the audio file once the rate is changed was not something that I expected. It would have been better if the position of the audio file had not been affected when I changed the playback rate" [16]. Four students stated that five different rates were not enough. One of them suggested, "It would have been better if a slider had been provided so that I could have chosen the best audio playback rate for myself" [17].

### 4.4 Summary of Results

1. Control and Experimental Groups' Achievements in the Experimented Unit

The results of the study showed that the treatment in both groups improved the achievement scores of students significantly. However, the results indicated that there is no statistically significant median difference between experimental and control groups' achievements in pre and posttests.

2. Control and Experimental Groups' Attitudes Toward Computers

The results of the study indicated that there is no statistically significant median difference between experimental and control groups' attitudes toward computers in pre and posttests.

3. Control and Experimental Groups' Attitudes Toward Science Course

The results of the study showed that there is no statistically significant median difference between experimental and control groups' attitudes toward science course in pre and posttests.

4. Experimental Group's Tendencies in Using Audio Playback Rate-Control Tool

The analysis of computer logs indicated that the students mostly used the audio playback rate-control tool. The "normal" rate was used 50% of the time, "fastest" rate was used 26% of the time, and the "slowest" rate was used 15% of the time. The remaining 9% of the time was distributed as 6% for "fast" rate and 3% for "slow" rate.

5. Experimental Group's Perceptions of Instructional Software and Audio Playback Rate-Control Tool

Interview results of the study indicated that students' opinion about the instructional software that was used in this study was very positive. Most of the students stated that it would be better if the science course were supported with computer programs like the one they used during the experiment. In addition, interview results indicated that students used and liked the audio playback rate-control tool. The students stated that it would be beneficial to integrate such a tool in all instructional software.

# CHAPTER 5

# CONCLUSIONS, IMPLICATIONS AND RECOMMENDATIONS

This chapter discusses conclusions of the study, suggests implications for practice, and presents recommendations for further studies.

## 5.1 Conclusions

Computer assisted instruction (CAI) is an area of wide interest throughout the world. Theoretically, CAI can be used in teaching almost anything, however, this is not always desirable or successful. Thus the first principle for CAI should be applying CAI in ways that are more useful than traditional teaching methods. In order to realize this principle, high quality instructional applications should be developed by applying Instructional Design (ID) principles since the quality of CAI applications determines the success of learning process. ID principles provide directions for instructional strategies that are based on individual needs and differences. According to Reigeluth (1999, cited in Alessi & Trollip, 2001), ID models were developed during 1980s and 1990s that include cognitive and constructivist elements of learning process.

The idea of integrating audio playback rate-control tool into instructional software is based on one of the most important principles of ID that is considering learners' cognitive differences. Research studies related to cognitive speed provided guidance for this study. During the development of instructional software, the main focus was on developing a tool, which was easy-to-use and effective while emphasizing learners' cognitive differences.

Two CAI applications "Simple Machines Program with and without Audio Playback Rate-Control Tool" were developed to investigate how the use of additional auditory attribute (Audio Playback Rate-Control Tool) in instructional software affects the students' achievement, attitudes toward computers and science course, and perceptions of instructional multimedia with audio playback rate control attribute. The applications were self-study modules including all the information, illustrations, and examples in one stand-alone program. The CAI methodology applied was tutorial, emphasizing "real-life" examples. The experimental group used the software with audio playback rate control tool and control group used it without this tool.

### 5.1.1 Control and Experimental Groups' Achievements in the Experimented Unit

As stated in the purpose of the study, one of the main purposes of this study was to find out whether there was a statistically significant difference between the pre and post achievement tests scores of students who used the instructional software. The results showed that the treatment in both groups improved the achievement scores of students significantly. This means that instructional software with and without audio playback rate control tool helped the students learn the simple machines subject.

At the same time, as stated in the purpose of the study, another purpose was to investigate whether students learn better through using audio playback rate control tool in instructional multimedia. Although mean score of control group was higher than that of experimental group in both pre and post achievement tests, from the result of Mann Whitney U test, it was concluded that the difference is not statistically significant. As a result, it can be concluded that there is no significant median difference between the achievement scores of both groups in pre and posttests. So the first hypothesis of this study was accepted. In other words, comparison of the two groups' achievement scores indicated that using audio playback rate control tool did not result in better learning.

Several explanations might be offered on these findings. There might be factors affected students' achievement. In this study, subjects were not randomly assigned to either control or experimental group. Instead, the two naturally assembled groups as intact classes were assigned to these groups due to the restrictions of the school administration as explained in the method part of this study. Even though appropriate statistical analysis was used to eliminate the effects of nonequivalent groups assignment, in the beginning of the study, control group had moderately higher mean scores than that of experimental group in pre-test achievement. So it can be assumed that control group's students might be more successful in science course prior to treatment.

Another factor, which might be influential on results of achievement scores of two groups, could be the short duration of the experiment. If the experiment lasted longer and the software included more units, the experimental group might have better use of the audio playback rate control tool and this might have resulted in higher scores in achievement test. In addition, because of time limitations, the retention of subjects in both groups could not be measured. However, learning is something that must be examined over time, and further studies should examine this issue. It would still be difficult to be certain that the experimental group would be more successful than the control group in achievement test if the factors stated above could have been eliminated.

Students who used instructional multimedia with audio playback rate control attribute were provided more user control. The result of this study indicated that instructional multimedia with audio playback rate control attribute, which gives additional control to learners is as effective as instructional multimedia which do not have audio playback rate control attribute in regard to learning outcome. The findings of this study are in accordance with the Santiago and Okey's (1990, cited in Schwier, 1995) conclusion on learner control research. They stated that giving the learner control may increase motivation to learn but it does not necessarily increase achievement.

### 5.1.2 Control and Experimental Groups' Attitudes Toward Computers

The second question of this study was related with students' attitudes toward computers. The results of statistical analysis indicated that there was no statistically significant difference between the two groups pertaining to their attitudes toward computers.

Experimental group had slightly higher mean scores than that of control group in both pre and posttests. However, the difference is not statistically significant as proved through the Mann-Whitney U test. These findings also indicate that the experimental and control groups' posttest scores are slightly higher than that of pretest scores showing that treatments in multimedia learning environments affected students' attitudes toward computers positively.

Short treatment time could be a reason for no significance difference between the experimental and the control groups' attitudes toward computers. The treatment lasted three weeks. This amount of time might not offer the potential for changing attitude toward computers. There are number of research studies which are inline with this study indicating the effects of treatment time on attitudes toward computers. For example, Keman and Howard (1990) indicated "interactions with the computer itself, especially over a 12-13 week period may change one's view of computers" (p. 689). In the present study, the treatment improved the mean score of experimental group's students in computer attitude scale from 3.31 (for pretest) to 3.41 (for posttest) showing that students have already positive attitudes toward computers before the treatment, and the treatment moderately improved their attitude scores toward computers.

### 5.1.3 Control and Experimental Groups' Attitudes Toward Science Course

The third question of this study was related with students' attitudes toward science course. The results of statistical analysis indicated that there was no statistically significant difference between the experimental and control groups' attitudes toward science course. Even though control group had slightly higher mean scores than that of experimental group in both pre and posttests, the difference is not statistically significant as proved through the Mann-Whitney U test. These findings also indicated that the experimental and control groups posttest scores were slightly higher than that of pretest scores suggesting that treatments in multimedia learning environments affected students' attitudes toward science course positively.

In the literature, there are many studies (Hounshell & Hill, 1989; Stratford & Finkel, 1996) investigating whether there were differences in attitudes towards science course between students exposed to computer-assisted instruction and students in traditional science course. In Hounshell and Hill's (1989) study, the results indicated that the computer program in the study helped make students' science course attitudes more positive. On the other hand, Stratford and Finkel (1996) found no significant differences in attitudes toward science course between the students exposed to computer-assisted instruction and students in traditional science course. Stratford and Finkel (1996) explained some factors such as insufficient time that could have been a reason why no significant differences were found.

These two different research results indicate that there is no consensus in the literature on the effects of computer-assisted instruction on students' attitudes toward science course. However, in this study, the aim was not to compare computer-assisted instruction and traditional way of teaching. Therefore, the findings of this study could not be compared or supported by current literature. In the present study, subjects in experimental and control groups used two versions of the same instructional multimedia. The only difference was presence or absence of audio playback rate control tool. Experimental groups' instructional multimedia had audio playback rate control tool and control groups' software did not have this tool.

The findings of this study indicated that the audio playback rate control tool was not effective in changing students' attitudes towards science course. Some explanations could account for the findings of the present study. A possible explanation may be that the students were not able to recognize the use of audio playback rate control tool within the short time period. So the time period of treatment (3 weeks) was not long enough to cause a significant change in attitudes. Longer duration of the treatment could possibly have had a bigger impact on attitudes.

### 5.1.4 Experimental Group's Tendencies in Using Audio Playback Rate-Control Tool

During the treatment, the experimental group used the normal speed 50% of the time, the fastest speed 26% of the time, and the slowest speed 15% of the time. These findings show that the subjects preferred to use, first, the normal speed, second, the fastest speed, and the third, the slowest speed. The most interesting result is that most of the times, students did not prefer slow and fast rates which were middle rates between normal and the slowest, and normal and the fastest rates. Another important result from this study was that the students preferred having audio speed up. This result is consistent with Harrigan's (1995) findings. He found that learners preferred using the system at the faster speeds.

This result of the study supports the idea that different learners need different instruction since learners differ in their interests, their speed of learning and their ways of using strategies (Mayer & Moreno, 2000). The findings indicated that the students have chosen different playback speeds for their own individual cognitive capacities and needs. In addition, Fulford (2001) stated, "Input from the five senses fills the working memory to the limit moment by moment" (p. 31). As the working memory fills, data are processed, and information is pushed into long-term memory (Fulford, 2001). However, the cognitive capacity of working memory is limited (Miller, 1956, cited in Fulford, 2001), as a result, some information may be lost. Therefore, to maximize learning, working memory input should be limited to cognitive speed of learners. The analysis of computer logs yielded some evidence supporting Fulford's statement. For example, 16% of the students listened to the audios only once. The remaining 84% of the students listened to the audio files in instructional multimedia more than one time.

The students who listened to the audio files in instructional multimedia more than one time have different patterns such as, 34% of the them listened to the same audio file in the normal speed at first and then very fast speed secondly, 23% of the them listened to the same audio file in the normal speed at first and then again normal speed secondly, 16% of the them listened to the same audio file in the normal speed at first and then very slow speed secondly, and the remaining 27% of the students listened to the audio files different than these patterns. These patterns may indicate that students' cognitive speeds are so different. Some students listened to the audio file in normal speed at first and did not need to listen to it again; some students listened to the audio file in normal speed at first and needed to listen to it again in faster or slower speed according to their cognitive capacities and speeds.

During the analysis of computer logs, the relationship between student achievements and usage patterns were also investigated. No common patterns were found for high achiever and low achiever students' usage of audio playback rate control tool. For example, the student who gets 33 out of 100 from post achievement test listened to the audios mostly (75% of the time) in the very fast speed, and the student who gets 84 out of 100 from post achievement test listened to the audios almost the same amount of time (78% of the time) in the very fast speed. This was the case for most of the low and high achiever students' usage patterns of audio playback rate control tool. Therefore, the results indicated that there was no relationship between the learning outcomes and the usage patterns.

Harrigan (1995) claimed that the system that allows the learner to change the speed of the audio portion at any time to faster or slower rate could lessen the time required to learn the material. Even though the aim of the present study was not measuring and comparing the time required for students to learn the presented unit, the audio playback rate control usage patterns showed that the students in the experimental group used the tool according to their learning speed. During the interview, some students stated that "very fast rate" was effective in saving time supporting Harrigan's statement. One of the students, as stated in the results part of the study, explained his rationale for this as the following: "The audio-videos in the instructional software's being very slow rate increased my concentration. If they were fast, I could miss some details. At the same time, since I selected the 'very slow' rate, it was possible for me to get the information at once. For this reason, I may claim that I learnt the topics in a shorter time".

### 5.1.5 Experimental Group's Perceptions of Instructional Software and Audio Playback Rate-Control Tool

As a conclusion to the interview results the researcher would say the students' opinions toward both instructional software and audio playback rate-control tool were positive. The analysis of interview data clearly showed that the effort to integrate audio playback rate-control tool in instructional multimedia has been worthwhile since the students used and liked the audio playback rate-control tool.

In general, it can be stated that students' feedback about the instructional software that was used in this study was very positive. The students liked the program and no major problems were found. During the experiment, the researcher observed that students did not face with any difficulties in using the software. The findings of the study are in parallel with this observation. Although audio playback rate control tool did not significantly affect students' achievement and attitudes, computer logs and interview results indicated that students used and liked the audio playback rate-control tool. In addition, students who used instructional software with and without audio playback rate-control tool did learn the topics and found the computer-assisted way of instruction as a good supplement to traditional methods as described in results part.

As mentioned in the results part of the study, most of the students (n=20) held the view that they preferred the presence of teacher while studying in the computer laboratory. This result is consistent with Yıldırım and Özden's (2001) finding in their study which was titled as "Students' Perceptions of a Hierarchically-

Designed Hypermedia Learning Environment". They stated, "... it would be better when the hypermedia was used with a teacher present in the computer lab" (p. 72). Therefore, in future classroom applications, the presence of the teachers in the laboratory environment is advocated.

It can also be concluded that the audio playback rate control tool helped the students in especially learning the "difficult subjects". As one of the students stated, "While dealing with difficult subjects, ... using the 'very slow' rate aided me in learning the subject ..." Another student, advocated the audio playback rate control tool from another point of view; which is that the tool, when especially the 'very slow' rate is chosen, increases his concentration. He said, "... the very slow rate increased my concentration. If they were fast, I could miss some details..." Although there was no significant difference between experimental and control groups in their achievements, the interview results provided the information that the use of audio playback rate control tool may contribute to the students' learning according to their perceptions.

During the interview, students stated some suggestions for improving the software and audio playback rate control tool. Some students suggested that if the software includes real-time compressing/expanding of audio files, they might feel more comfortable. The interview results also indicated that some students perceive the computer as a game machine or toy. Therefore, it would be better to include some game features into instructional multimedia. Vogelzang (1996) stated games' importance as, "A fundamental issue linking learning, computers, and motivation is games" (p. 6).

## 5.2 Implications

Interview results indicate that students used and liked the audio playback rate-control tool. The students stated that it would be beneficial to integrate such a tool in all instructional software. This might suggest that instructional software that contain audio playback rate-control tool will regard the diversity of learner differences and learning styles more, and therefore, will allow learners to listen audio at their own rates. Knowing the wpm limits of audio comprehension, and designing instructional materials in light of these limits while allowing learners to adjust the playback rate according to their storage and retrieval capacity would be beneficial to develop effective multimedia learning materials. Therefore, it can be implemented and tested in instructional multimedia in other subject areas. For example, instructional multimedia developers may design such materials through which language teaching would be possible and even student evaluation in such cases could be involved in the courseware.

Other than these, as stated in the results chapter, the students may not face with any problems in using such software when the software is designed well considering the basic design principles like using composite of linear and non-linear navigation strategies together. Therefore, it would be beneficial to use such navigation strategy in instructional software for eight grade students. The designers of instructional multimedia applications may consider using the result of this study.

In practical cases when such instructional multimedia is involved in the learning environment the existence of a teacher in the computer laboratory and as a part of this, teacher guidance would be preferred by most of the learners (n=20 of

24) as stated in the results part. One of the student stated, "I would prefer to use the software when the instructor is around…" Therefore, the results of the present study indicated that multimedia-learning environment could be more effective when instructional multimedia is used together with teacher.

The period of both development and implementation of the software was restricted. This disadvantage resulted in decreasing the number of exercises and tests. Some of the students stated that the software should include more interactive exercises and tests. The suggestions of the students also have a reflection of this disadvantage. Therefore, attention should be paid into including more interactive exercises and tests. This may increase learners' motivation.

There was a gap in the instructional multimedia development field especially on the investigation of audio playback rate control. This study, eventually, contributes to the literature in that sense. In addition, there are no similar studies conducted in Turkey in the literature. The present study provides an example in the field of instructional multimedia design and its applications at schools in Turkey.

## 5.3 Recommendations for Further Studies

This study has some limitations. Therefore, keeping in mind the limitations of the study, the study can be redesigned accordingly, covering the same subject area and for the same grade level but for a longer period of time with similar (equivalent) groups. At the same time, it can be recommended to design a study investigating the use of audio playback rate control tool in instructional multimedia while teaching a different subject area to a different grade level. For example, the study can be designed for usage of the tool while teaching foreign languages. Such an investigation regarding the foreign language teaching could provide valuable information for the literature.

The design of the study did not allow the researcher to find out students' learning time. Therefore, additional research is needed to investigate learning efficiency in terms of learning per unit of time. Also, through redesigning the study, the student evaluation may also be involved in the process. In other words, the questions in a timed test, could be provided to the students through the instructional multimedia with audio playback rate control tool and as a result it could be possible for the researcher to investigate the time-success relationship in understanding the questions.

The audio files used in this software were not time compressed/expanded in real time. When the students changed the rate of the audio playback, they had to follow the audio file from the very beginning of it. If the software is developed to include real-time compressing/expanding audio files the students may feel more comfortable. A further study may be conducted to investigate how such developments in design features would affect the attitudes and achievement of the students in using the software. Another aspect in further research is to move from the single machine usage to network. The ultimate goal for CAI application would be to have it available on-line for everyone through the Internet. A considerable development is currently going on WWW and related Internet technologies all over the world. Microsoft .NET, Java, real-time video conferencing and network audio, the current hot topics of Internet, are likely to make truly interactive education possible. For example, an online CAI server allowing learners to change the playback rate of audio and video in real-time would open totally new possibilities for foreign language education. This type of online applications should be developed, and researched for their effectiveness.

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# APPENDIX A

# SCREENSHOTS OF THE INSTRUCTIONAL SOFTWARE

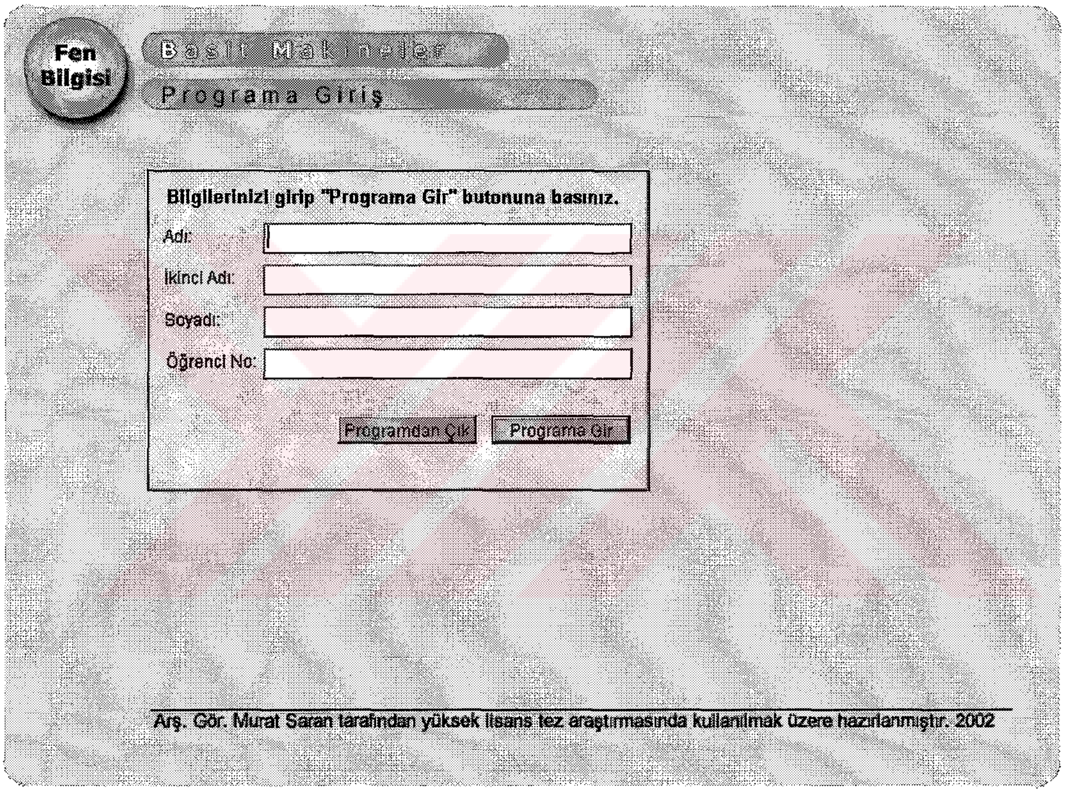



Figure A.1 Login screen.

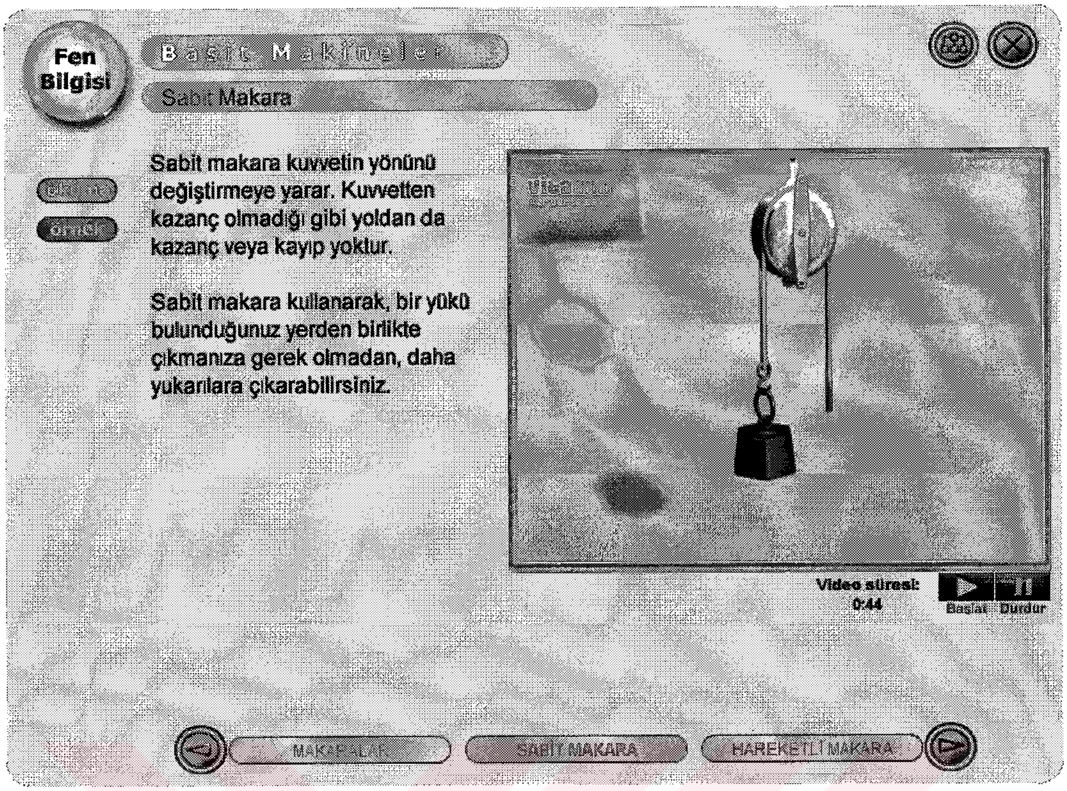



Figure A.2 Instructional screen without audio playback rate-control tool.

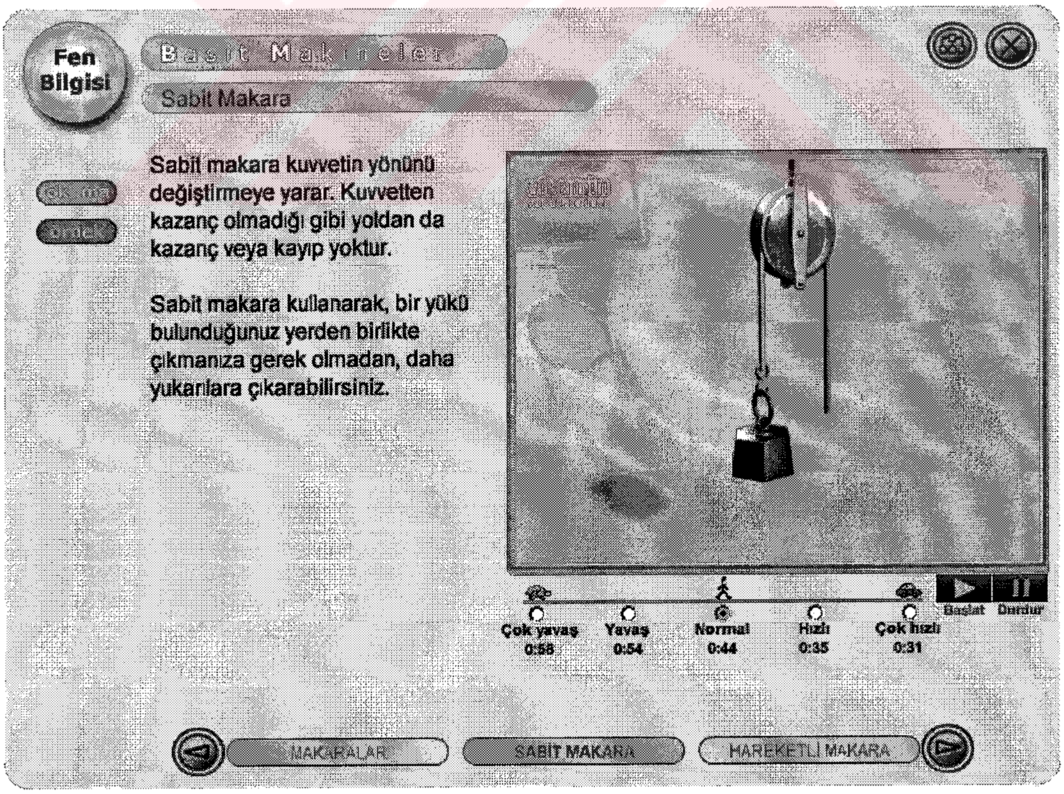



Figure A.3 Instructional screen with audio playback rate-control tool.

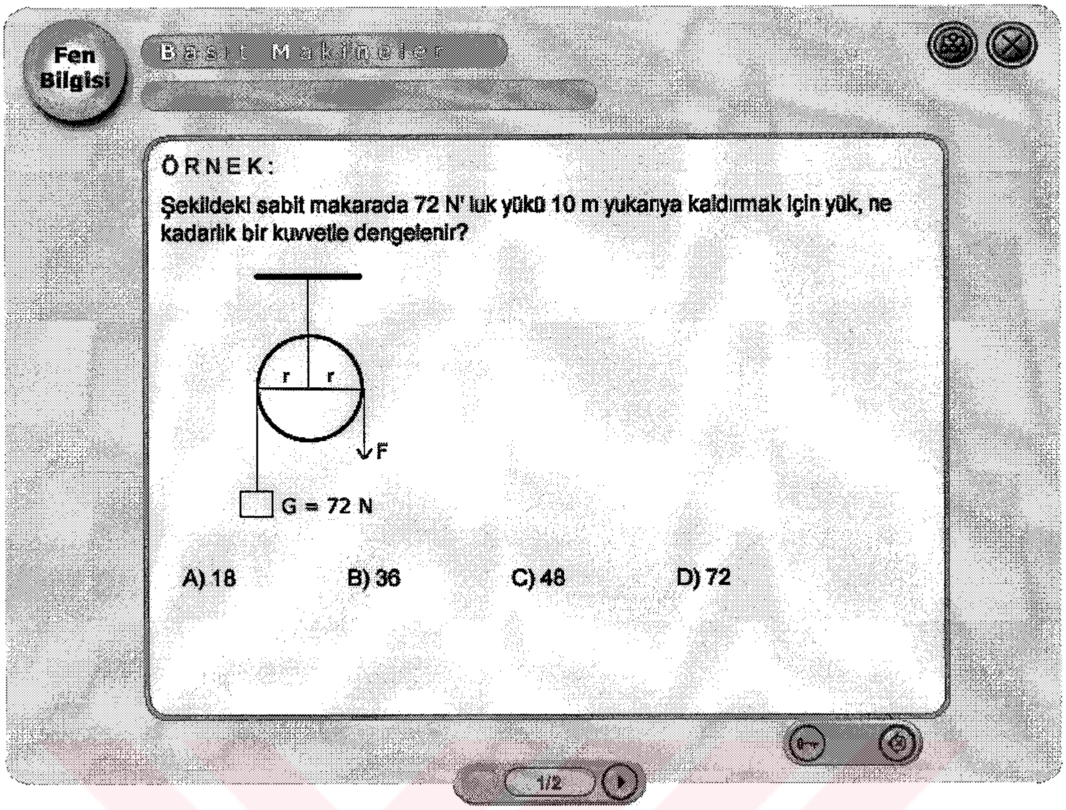



Figure A.4 Exercise screen.

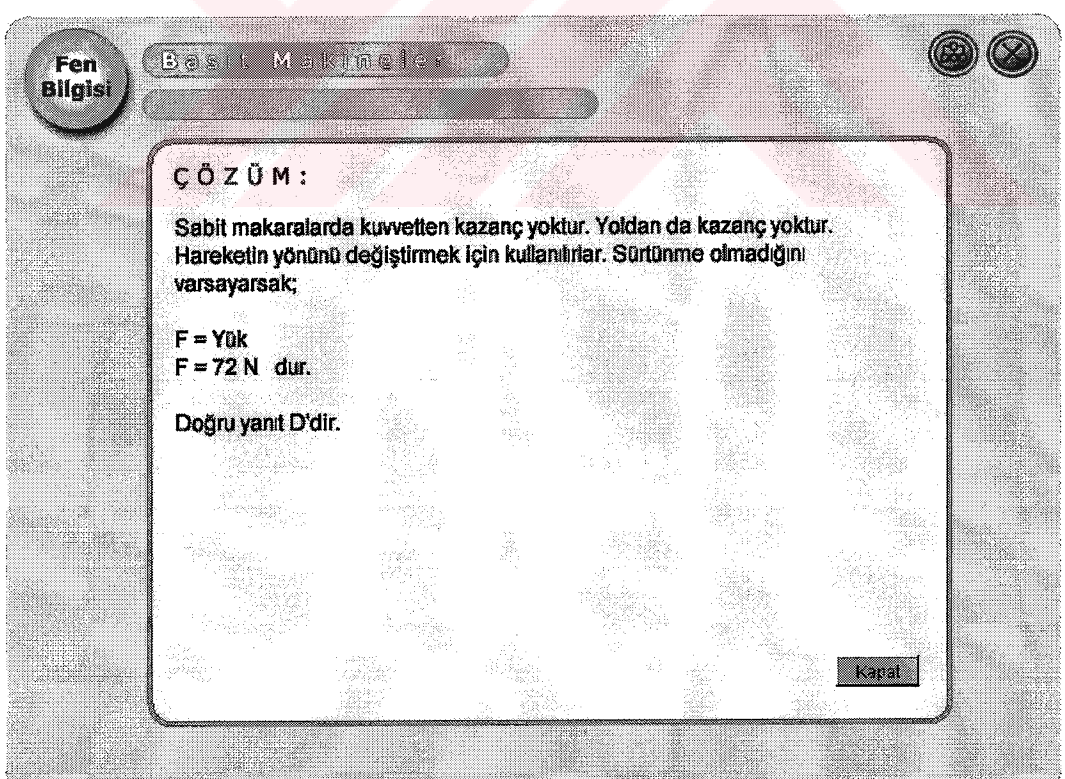



Figure A.5 Solution screen.

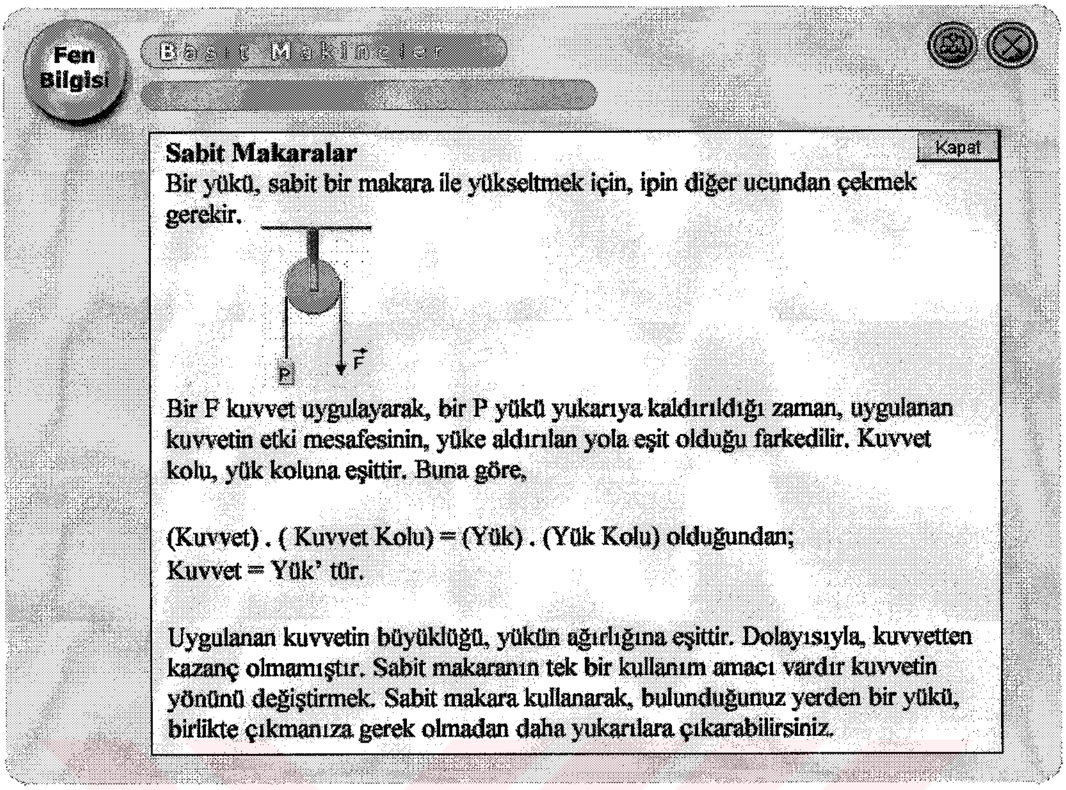



Figure A.6 Reading screen.

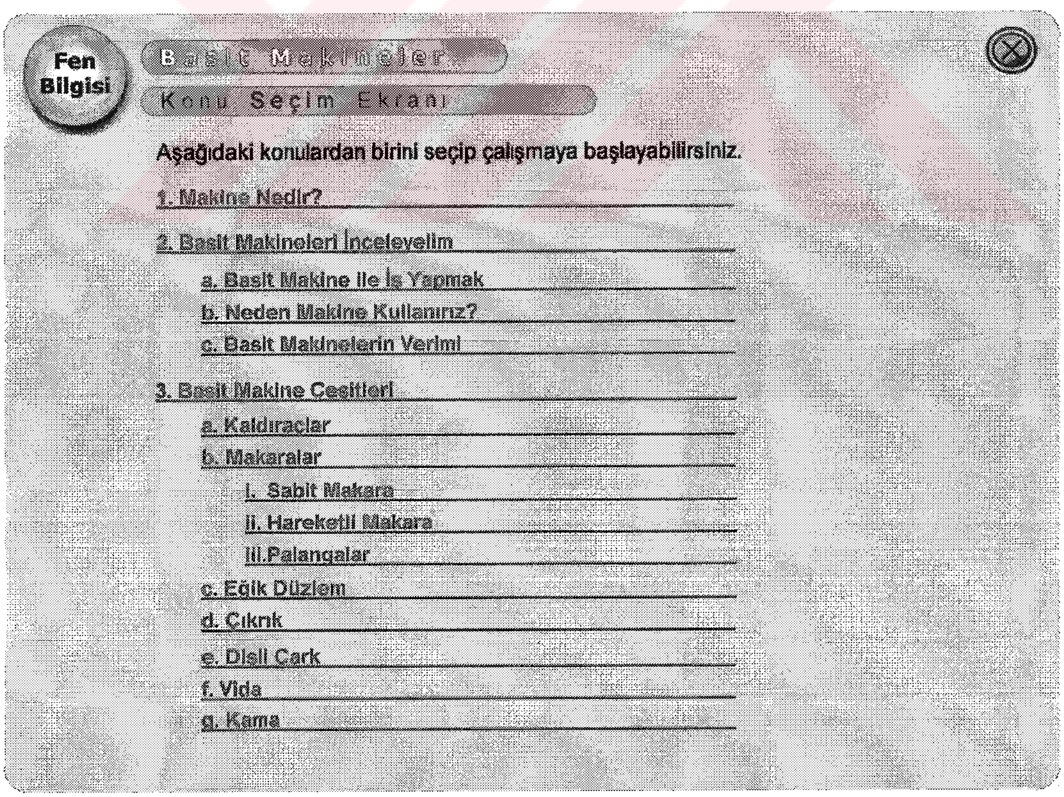
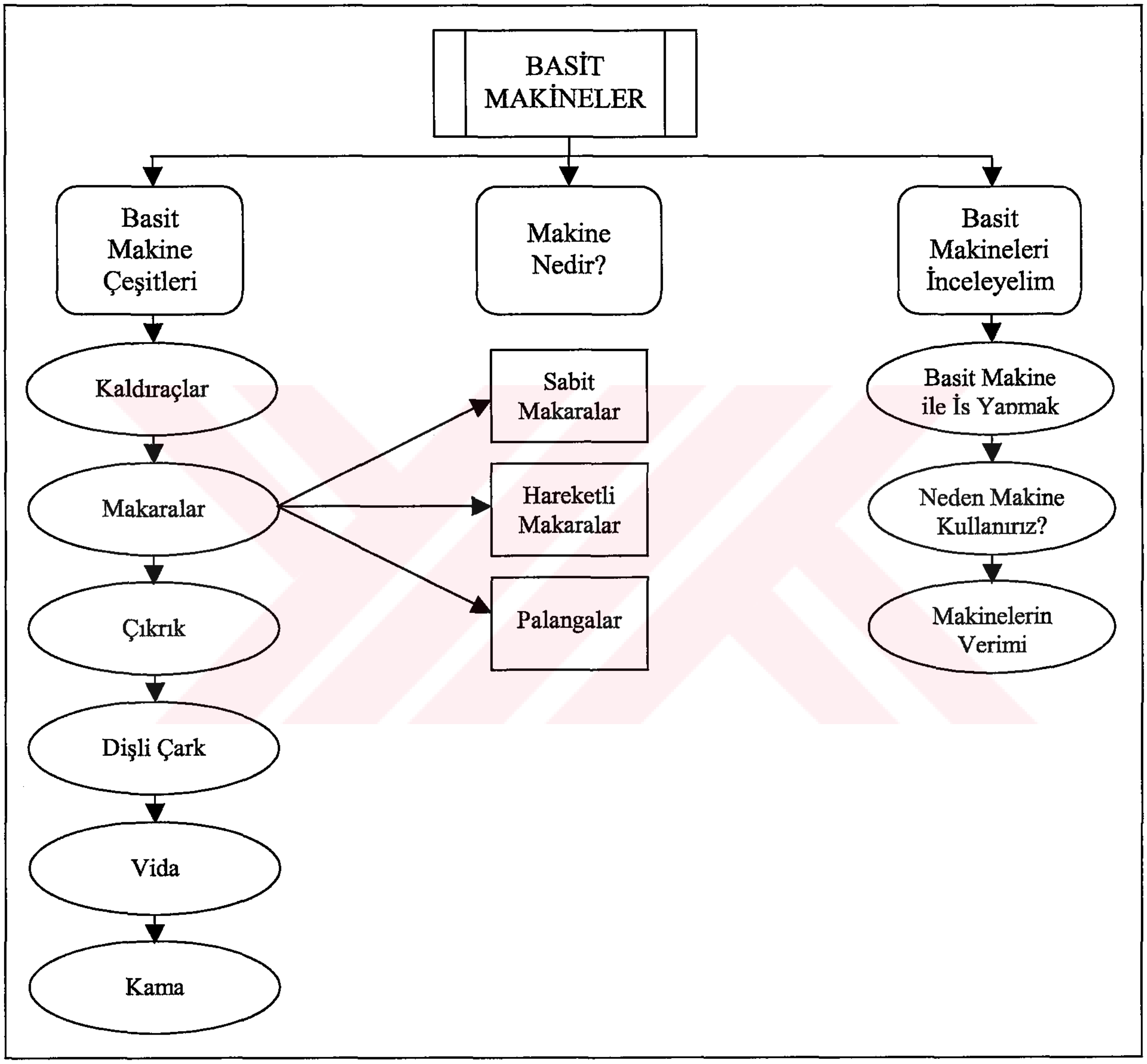



Figure A.7 Menu screen.

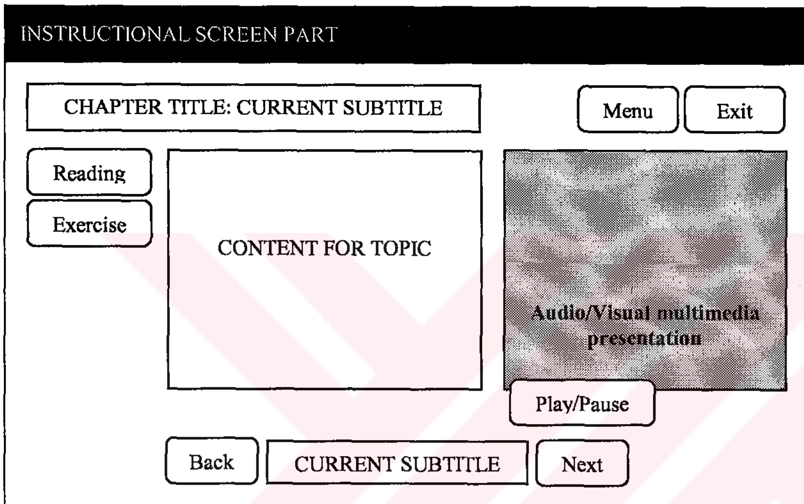
## APPENDIX B

## CONCEPT MAP



# APPENDIX C

# STORYBOARD




| No: 4 | NAME: WHY WE USE SIMPLE MACHINES? |
|---|---|
| COMPONENTS | |
| 4.L1 (Sub) Title Field<br>4.S1 Topic Content<br>4.V1 Content Related Audio/Visual<br>4.B1 Play/Pause Button<br>4.B2 Back Button<br>4.B3 Next Button<br>4.B4 Reading Button<br>4.B5 Exercise Button<br>4.B6 Menu Button<br>4.B7 Exit Button | |
| EVENT TYPE | |
| Non-interactive | 4.S1 |
| Interactive | 4.B1, 4.B2, 4.B3, 4.B4, 4.B5, 4.B6, 4.B7 |

DESCRIPTIONS

4.L1: This part presents the title of the chapter and the subtitle under which the learner is to start instruction.
4.S1: This field presents content for the selected topic.
4.V1: When topic is displayed, this part displays audio/visual multimedia presentation related to selected topic.
4.B1: It is a Play/Pause Button. Learner can start and resume multimedia presentation by clicking the button.
4.B2: It is a back button. Learner can initiate the previous screen of the instruction by clicking the button.
4.B3: It is a next button. Learner can initiate the next screen of the instruction by clicking the button.
4.B4: It is a reading button. Learner can reach the additional text-based information related to selected topic.
4.B5: It is an exercise button. Learner can initiate the exercises related to selected topic.
4.B6: It is a menu button. Learner can reach the menu of contents.
4.B7: It is a exit button. Learner can exit the program.

# APPENDIX D

# ACHIEVEMENT TEST

### Fen Bilgisi Dersi "Basit Makineler" Konusu Test

**Öğrenci Numaranız: ...............**

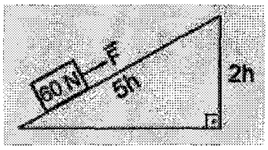
**Açıklamalar:** Bu test, sizin "Basit Makineler" konusu hakkında ne kadar bilgi sahibi olduğunuzu öğrenmek amacıyla hazırlanmıştır. Herbir soru 1 puan değerindedir. Lütfen sadece emin olduğunuz soruları işaretleyiniz. Başarılar!

1) Basit makinelerle iş yapılırken;

I.Enerji kazanmak,
II. Kuvvetten kazanç sağlamak,
III.Zamandan kazanmak,
olaylarından hangisi veya hangileri **gerçekleşir?**

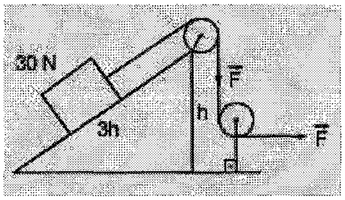
A. Yalnız I B. Yalnız II C. I ve II D. II ve III

2) Şekildeki eğik düzlemde 60 N'luk yükü yukarı çıkarabilmek için **kaç N'luk kuvvet gereklidir?** (Sürtünmeler dikkate alınmayacak).



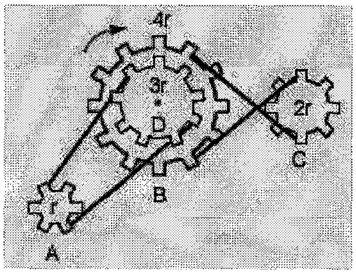

A. 18 B. 20 C. 24 D. 30

3) Sürtünmesiz eğik düzlem üzerindeki **yükü dengeleyen F kuvveti kaç N'dur?**




A. 10 B. 15 C. 20 D. 30

4) Şekildeki dişli çarkta, kademeli B dişlisi ile okun yönünde 1 devir yaparsak A ve C nin dönüş yönü ve devir sayısı için hangisi **doğru** olur?



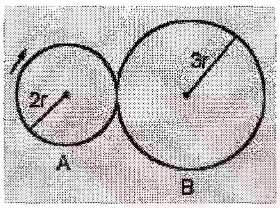

A. A dişlisi 1 devir ok yönünde,
C dişlisi 2 devir okun ters yönünde

A. A dişlisi 3 devir ok yönünde,
C dişlisi 2 devir okun ters yönünde

C. A dişlisi 3 devir okun ters yönünde
C dişlisi 1 devir ok yönünde

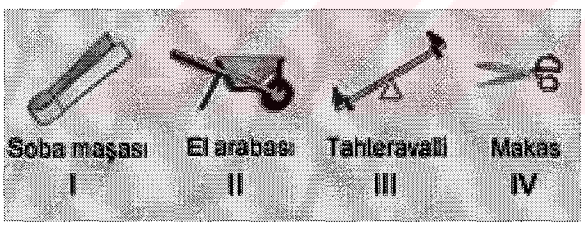
D. A dişlisi 1 devir okun ters yönünde
C dişlisi 2 devir ok yönünde

5) A dişlisi 6 devir yaparsa, **B dişlisi kaç devir yapar**?



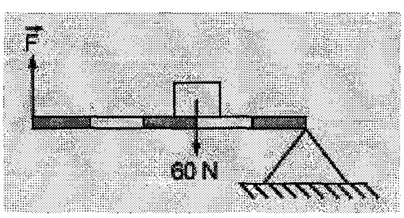

A. 1  B. 2  C. 4  D. 6

6) Şekildeki basit makinelerden hangi ikisi **aynı** kaldıraç tipine örnektir?



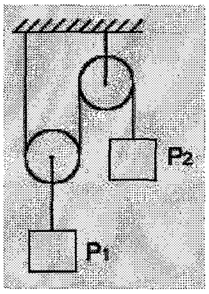

A. I ve II  B. I ve III  C. II ve III  D. III ve IV

7) Şekildeki kaldıraçta yükü dengeleyen **kuvvetin büyüklüğü kaç N'dur?**



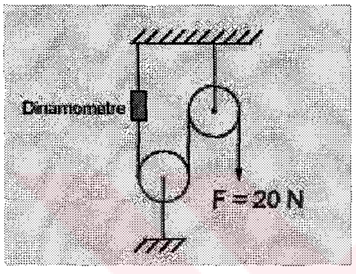

A. 24  B. 28  C. 30  D. 38

8) Şekildeki sistemde makara ağırlıkları $P_1$ kadardır. Sistem dengede olduğuna göre $\frac{P_1}{P_2}$ kaçtır?



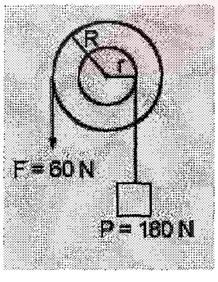

A. 1 B. 2 C. 3 D. 4

9) Şekildeki düzenekte F=20 N ise, **dinamometre kaç Newton'u gösterir?**



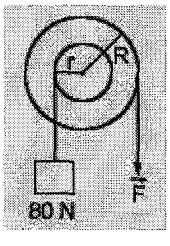

A. 1 B. 2 C. 3 D. 4

10) Şekildeki çıkrıkta 180 N'Iuk yük 60 N'Iuk kuvvet ile dengelendiğine göre; $\frac{R}{r}$ oranı kaçtır?




A. 1 B. 3 C. 1/2 D. 1/3

11) Şekildeki çıkrıkta $\frac{r}{R} = \frac{1}{4}$ ise, yükü dengeleyen **F kuvveti kaç N'dur?**

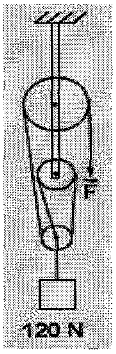



A. 4 B. 20 C. 24 D. 40

12) Vida adımı aşağıdaki makinelerden hangisinde kullanılır?

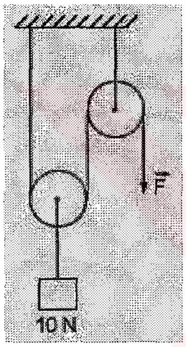
A. Eğik düzlem B. El arabası C. Araba krikosu D. Tahteravelli

13) Şekildeki palangada yükü dengeleyen **kuvvet kaç N'dur?** (Makara ağırlığı ve sürtünmeler dikkate alınmayacak).



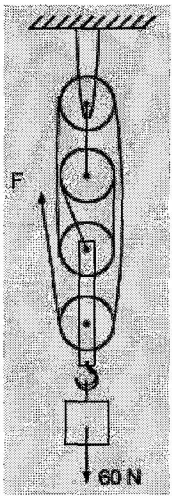

A. 4 B. 20 C. 24 D. 40

14) Şekildeki her bir makaranın ağırlığı 6N'dur. Yükü dengeleyen **kuvvet kaç N'dur?**




A. 5 B. 6 C. 8 D. 10

15) Şekildeki palangada yükü dengeleyen **kuvvetin büyüklüğü kaç N'dur?** (Makara ağırlığı ve sürtünmeler dikkate alınmayacak.)




A. 5 B. 6 C. 8 D. 10

## APPENDIX E

## COMPUTER ATTITUDE SCALE

### Bilgisayara Yönelik Tutum Ölçeği

**Öğrenci Numaranız: ...............**

Açıklamalar: Bu ölçekte **"Bilgisayara"** ilişkin tutum cümleleri ile her cümlenin karşısında **"Kesinlikle Katılıyorum, Katılıyorum, Katılmıyorum, Kesinlikle Katılmıyorum"** olmak üzere dört seçenek verilmiştir. Araştırmanın amacı, sizlerin bilgisayar konusundaki düşüncelerinizi öğrenmektir. Bu nedenle her cümleyi dikkatle okuduktan sonra her cümle için kendinize uygun olan seçeneği işaretleyiniz. Lütfen cevapsız soru bırakmayınız. Cevaplarınız kesinlikle gizli tutulacaktır. Yardımlarınız için teşekkür ederiz.

| | Kesinlikle Katılıyorum | Katılıyorum | Katılmıyorum | Kesinlikle Katılmıyorum |
|---|---|---|---|---|
| 1. Bilgisayarlar beni hiç korkutmuyor. | O | O | O | O |
| 2. Bilgisayar kullanma konusunda hiç iyi değilim. | O | O | O | O |
| 3. Bilgisayarlarla çalışmayı isterim. | O | O | O | O |
| 4. Bilgisayarı yaşamımda birçok biçimde kullanacağım. | O | O | O | O |
| 5. Bilgisayarlarla çalışmak beni çok sinirli yapar. | O | O | O | O |
| 6. Genellikle, bilgisayarda yeni bir problemle uğraşırken kendimi rahat hissederim. | O | O | O | O |
| 7. Bilgisayarlarla problemleri çözmek bana cazip gelmez. | O | O | O | O |
| 8. Bilgisayarlar hakkında birşeyler öğrenmek zaman kaybıdır. | O | O | O | O |
| 9. Başkaları bilgisayarlardan söz ettiğinde rahatsızlık duymuyorum. | O | O | O | O |
| 10. İleri düzeyde bir bilgisayar çalışması yapacağımı düşünmüyorum. | O | O | O | O |
| 11. Bilgisayarlarla çalışmanın zevkli ve teşvik edici olduğunu düşünüyorum. | O | O | O | O |

| | | | | |
|---|---|---|---|---|
| 12. Bilgisayarlar hakkında bilgi edinmek zahmete değer. | O | O | O | O |
| 13. Bilgisayarlara karşı saldırgan ve düşmanca olduğumu hissediyorum. | O | O | O | O |
| 14. Bilgisayarlarla çalışabileceğime eminim. | O | O | O | O |
| 15. Bilgisayar problemlerini çözmeye çalışmak bana çekici gelmiyor. | O | O | O | O |
| 16. Gelecekteki çalışma hayatım için bilgisayar kullanım hakimiyetine ihtiyacım olacak. | O | O | O | O |
| 17. Bilgisayar dersi almak için zahmete girmem. | O | O | O | O |
| 18. Bilgisayarlarla iyi şeyler yapmak için uygun biri değilim. | O | O | O | O |
| 19. Bir bilgisayar programında hemen çözemediğim bir sorun olduğunda cevabı bulana kadar vazgeçmem. | O | O | O | O |
| 20. Günlük hayatımda bilgisayarları çok az kullanacağımı tahmin ediyorum. | O | O | O | O |
| 21. Bilgisayarlar kendimi rahatsız hissetmeme neden olurlar. | O | O | O | O |
| 22. Bir bilgisayar dili öğrenebileceğime eminim. | O | O | O | O |
| 23. Bazı insanların nasıl olupta bilgisayarla bu kadar zaman harcadıklarını ve bundan nasıl bu kadar hoşlandıklarını anlamıyorum. | O | O | O | O |
| 24. Meslek hayatımda bilgisayarı kullanabileceğim bir durum düşünemiyorum. | O | O | O | O |
| 25. Bilgisayar dersinde rahat olduğumu hissediyorum. | O | O | O | O |
| 26. Bilgisayar kullanmanın benim için çok zor olduğunu düşünüyorum. | O | O | O | O |
| 27. Bilgisayarlarla çalışmaya başlayınca bırakmak oldukça zor gelir. | O | O | O | O |
| 28. Bilgisayarlarla çalışmayı bilmek, iş bulma olanaklarını artıracaktır. | O | O | O | O |
| 29. Bilgisayar kullanmayı düşündüğümde başımdan aşağı kaynar sular boşaldığını hissediyorum. | O | O | O | O |
| 30. Bilgisayar ile ilgili derslerde iyi notlar alabilirim. | O | O | O | O |
| 31. Bilgisayarlarla mümkün olduğunca az çalışmalar yapacağım. | O | O | O | O |
| 32. Bilgisayarla çözülebilecek herşeyi başka yollarlada çözebilirim. | O | O | O | O |
| 33. Bilgisayarlarla çalışırken kendimi rahat hissederim. | O | O | O | O |
| 34. Bir bilgisayar dersini becerebileceğimi sanmıyorum. | O | O | O | O |
| 35. Eğer bilgisayar dersinde bir problem çözülmeden kalırsa üzerinde sonradan düşünmeye devam ederim. | O | O | O | O |
| 36. Bilgisayar derslerinde başarılı olmak benim için önemlidir. | O | O | O | O |
| 37. Bilgisayarlar beni huzursuz eder ve aklımı karıştırır. | O | O | O | O |
| 38. Bilgisayarla çalışmak gerektiğinde kendime yeterince güvenirim. | O | O | O | O |
| 39. Başkalarıyla bilgisayar hakkında konuşmaktan hoşlanmam. | O | O | O | O |
| 40. Çalışma hayatımda bilgisayarlarla çalışmanın benim için önemi olmayacaktır. | O | O | O | O |

## APPENDIX F

## SCIENCE COURSE ATTITUDE SCALE

### Fen Bilgisi Dersine Yönelik Tutum Ölçeği

**Öğrenci Numaranız: ...............**

Açıklamalar: Bu ölçekte **"Fen Bilgisi"** dersine ilişkin tutum cümleleri ile her cümlenin karşısında **"Kesinlikle Katılıyorum, Katılıyorum, Kararsızım, Katılmıyorum, Kesinlikle Katılmıyorum"** olmak üzere beş seçenek verilmiştir. Araştırmanın amacı, sizlerin Fen Bilgisi dersi hakkındaki düşüncelerinizi öğrenmektir. Bu nedenle her cümleyi dikkatle okuduktan sonra her cümle için kendinize uygun olan seçeneği işaretleyiniz. Lütfen cevapsız soru bırakmayınız. Cevaplarınız kesinlikle gizli tutulacaktır. Yardımlarınız için teşekkür ederiz.

| | Kesinlikle Katılıyorum | Katılıyorum | Kararsızım | Katılmıyorum | Kesinlikle Katılmıyorum |
|---|---|---|---|---|---|
| 1. Fen Bilgisi dersini severim. | O | O | O | O | O |
| 2. Fen Bilgisi dersi sevimsizdir. | O | O | O | O | O |
| 3. Fen Bilgisi dersi ile ilgili konuları tartışmaktan hoşlanırım. | O | O | O | O | O |
| 4. Fen Bilgisi dersi ile ilgili bilgiler can sıkıcıdır. | O | O | O | O | O |
| 5. Fen Bilgisi dersi zihnin gelişimine yardımcı olur. | O | O | O | O | O |
| 6. Fen Bilgisi dersi beni huzursuz eder. | O | O | O | O | O |
| 7. Fen Bilgisi ile ilgili ders saatlerinin daha çok olmasını isterim. | O | O | O | O | O |
| 8. Fen Bilgisi dersi konuları rahatlıkla öğrenilebilir. | O | O | O | O | O |
| 9. Fen Bilgisi ile ilgili sınavlardan korkarım. | O | O | O | O | O |
| 10. Fen Bilgisi dersi ilgimi çeker. | O | O | O | O | O |
| 11. Fen Bilgisi dersi aklımı karıştırır. | O | O | O | O | O |
| 12. Fen Bilgisi dersini severek çalışırım. | O | O | O | O | O |
| 13. Fen Bilgisi dersini, elimde olsa, öğrenmek istemezdim. | O | O | O | O | O |
| 14. Fen Bilgisi dersi ilginç değildir. | O | O | O | O | O |
| 15. Fen Bilgisi konuları ile ilgili ileri düzeyde bilgi edinmek isterdim. | O | O | O | O | O |
| 16. Fen Bilgisi dersini çalışırken canım sıkılır. | O | O | O | O | O |

| | | | | | |
|---|---|---|---|---|---|
| 17. Fen Bilgisi dersi kişinin kendini tanımasını sağlar. | O | O | O | O | O |
| 18. Fen Bilgisi adını bile duymak sinirlerimi bozuyor. | O | O | O | O | O |
| 19. Fen Bilgisi dersinden korkarım. | O | O | O | O | O |
| 20. Fen Bilgisi konuları herkesin öğrenmesi gereken konulardır. | O | O | O | O | O |
| 21. Fen Bilgisi dersinden hoşlanmam. | O | O | O | O | O |
| 22. Fen Bilgisi konularını anlatırken sıkılırım. | O | O | O | O | O |
| 23. Fen Bilgisi dersi okullarda öğretilmese daha iyi olur. | O | O | O | O | O |
| 24. Fen Bilgisi dersi eğlencelidir. | O | O | O | O | O |

## APPENDIX G

## INTERVIEW FORM

### Görüşme Formu

### Giriş

Merhaba. Bu görüşmeyi basit makineler dersini işlerken kullandığınız eğitim yazılımı ile özelliklede konuşmaların hızını ayarlayabilmenizi sağlayan araç ile ilgili görüş ve düşüncelerinizi öğrenmek amacı ile yapıyorum.Görüş ve önerilerinizin yazılımı geliştirme sürecine katkıda bulunacağına inanıyorum.Yaptığımız bu görüşmedeki bilgiler sadece bu araştırmada kullanılacak ve kişisel bilgiler kesinlikle gizli tutulacaktır. Görüşmenin yaklaşık yarım saat süreceğini tahmin ediyorum. İzin verirseniz görüşmeyi kaydetmek istiyorum. Bu şekilde hem zamanı daha iyi kullanabiliriz, hem de sorulara vereceğiniz yanıtların kaydını daha ayrıntılı tutma fırsatı elde edebilirim. Bu araştırmaya katılmayı kabul ettiğiniz için teşekkür ederim. Eğer görüşmeye başlamadan önce bana sormak istediğiniz sorular varsa bunları yanıtlamak istiyorum.

**Sorular**

1) Size Fen Bilgisi dersi Basit Makineler konusunu işlerken kullandığınız bu eğitim yazılımını nasıl buldunuz?
2) Size göre bu yazılımın olumlu ve olumsuz yönleri nelerdir? (avantajları, sınırlılıkları)
3) Bu yazılımın basit makineler konusunu öğretmek için iyi tasarlanmış bir yazılım olduğunu düşünüyor musunuz ? Neden? (Olumlu ve olumsuz cevap için)
4) Eğitim yazılımındaki konuşmaların hızını ayarlıyabilmenizi sağlayan aracı kullandınız mı? Neden kullandınız? Neden kullanmadınız?
5) Eğer sözkonusu aracı kullandıysanız bu araç basit makineler konusunu öğrenmenize katkıda bulundu mu? Bulunduysa nasıl? Bulunmadıysa neden?
6) Bu aracın hoşlandığınız yönleri nelerdir? Neden hoşlandınız?
7) Bu aracın hoşlanmadığınız yönleri nelerdir? Neden hoşlanmadınız?
8) Bu aracı geliştirmek gerekirse hangi özelliklerini değiştirmek ya da geliştirmek gerekir? (Neden? Öneriler istenecek)

# APPENDIX G

## EXAMPLE COMPUTER LOG-FILE

| | |
|---|---|
| 100000001 | Student Name Surname |
| 09:17:13 | PROGRAMA GİRİŞ |
| 09:17:13 | Makine Nedir Normal1 |
| 09:18:13 | play1 |
| 09:18:41 | MakineNedirCok Yavas1 |
| 09:18:50 | play5 |
| 09:19:33 | Bas Mak Inc Normal1 |
| 09:19:43 | Basit Mak Inc Yavas1 |
| 09:19:46 | play9 |
| 09:19:53 | play9 |
| 09:20:23 | Basit Makine Cesitleri |
| 09:20:31 | Kaldiraclar Normal1 |
| 09:20:36 | Kaldiraclar Yavas1 |
| 09:20:46 | play29 |
| 09:22:34 | example |
| 09:23:25 | Kaldiraclar Normal1 |
| 09:23:33 | Makaralar Normal1 |
| 09:23:38 | play31 |
| 09:23:58 | Sabit Makara Normal1 |
| 09:24:02 | Sabit Makara Yavas1 |
| 09:24:03 | play39 |
| 09:25:03 | Hareketli Makara Normal1 |
| 09:25:06 | Hareketli Makara Cok Hizli1 |
| 09:25:07 | play42 |
| 09:25:40 | Palangalar Normal1 |
| 09:25:49 | Palangalar Cok Hizli1 |
| 09:25:52 | play47 |
| 09:26:43 | Egik Duzlem Normal1 |
| 09:26:50 | Egik Duzlem Hizli1 |
| 09:26:57 | play53 |
| 09:27:12 | Egik Duzlem Cok Hizli3 |
| 09:27:18 | play52 |
| 09:27:54 | Bas Mak Inc Normal1 |
| 09:28:02 | Basit Mak Inc Cok Yavas1 |
| 09:28:08 | play10 |
| 09:28:36 | Basit Mak ile is Yap Normal1 |
| 09:28:43 | Basit Mak ile is Yap Yavas1 |
| 09:28:48 | play14 |
| 09:28:58 | Neden Mak Kullaniriz Normal1 |
| 09:29:02 | example |
| 09:29:37 | Neden Mak Kullaniriz Normal1 |
| 09:29:42 | play16 |
| 09:29:44 | NedenMakKullanirizCok Hizli1 |
| 09:29:52 | play17 |
| 09:29:55 | play17 |
| 09:30:01 | play17 |
| 09:30:03 | Basit Mak Verimi Normal1 |
| 09:30:08 | Basit Mak Verimi Cok Hizli1 |
| 09:30:13 | play22 |
| 09:30:42 | Basit Makine Cesitleri |
| 09:30:50 | Kaldiraclar Normal1 |
| 09:30:57 | Kaldiraclar Hizli1 |
| 09:31:02 | play28 |
| 09:31:10 | Makaralar Normal1 |
| 09:31:13 | Kaldiraclar Normal1 |
| 09:31:15 | example |
| 09:31:28 | Kaldiraclar Normal1 |
| 09:31:30 | Makaralar Normal1 |
| 09:31:32 | Sabit Makara Normal1 |
| 09:31:35 | Hareketli Makara Normal1 |
| 09:31:36 | Palangalar Normal1 |
| 09:31:39 | Egik Duzlem Normal1 |
| 09:31:43 | Cikrik Normal1 |
| 09:31:49 | Cikrik Hizli1 |
| 09:31:53 | play58 |
| 09:32:58 | example |
| 09:33:45 | Cikrik Normal1 |
| 09:33:47 | Disli Cark Normal1 |
| 09:33:55 | example |
| 09:34:10 | Disli Cark Normal1 |
| 09:34:18 | Disli Cark Hizli1 |
| 09:34:22 | play63 |
| 09:34:59 | Vida Normal1 |
| 09:35:06 | example |
| 09:35:22 | Vida Normal1 |
| 09:35:24 | Kama Normal1 |
| 09:35:28 | play71 |
| 09:36:15 | Kaldiraclar Normal1 |
| 09:36:20 | Makaralar Normal1 |
| 09:36:24 | Sabit Makara Normal1 |

| | |
|---|---|
| 09:36:28 | example |
| 09:36:59 | Sabit Makara Normal1 |
| 09:37:03 | Makaralar Normal1 |
| 09:37:03 | Kaldiraclar Normal1 |
| 09:37:08 | Basit Makine Cesitleri |
| 09:37:10 | Basit Mak Verimi Normal1 |
| 09:37:10 | Neden Mak Kullaniriz Normal1 |
| 09:37:12 | Basit Mak ile is Yap Normal1 |
| 09:37:17 | Basit Mak ile is Yap Cok Hizli1 |
| 09:37:22 | play12 |
| 09:38:15 | Bas Mak Inc Normal1 |
| 09:38:19 | Makine Nedir Normal1 |
| 09:38:23 | Makine Nedir Cok Hizli1 |
| 09:38:26 | Basit Mak ile is Yap Normal1 |
| 09:38:27 | Neden Mak Kullaniriz Normal1 |
| 09:38:30 | example |
| 09:38:34 | Neden Mak Kullaniriz Normal1 |
| 09:38:35 | Basit Mak Verimi Normal1 |
| 09:38:38 | Basit Makine Cesitleri |
| 09:38:42 | Kama Normal1 |
| 09:38:46 | Vida Normal1 |
| 09:38:49 | example |
| 09:38:53 | Vida Normal1 |
| 09:38:56 | Disli Cark Normal1 |
| 09:39:00 | example |
| 09:39:04 | Disli Cark Normal1 |
| 09:39:07 | Cikrik Normal1 |
| 09:39:10 | example |
| 09:39:45 | Cikrik Normal1 |
| 09:39:50 | Egik Duzlem Normal1 |
| 09:39:52 | example |
| 09:40:00 | Egik Duzlem Normal1 |
| 09:40:03 | Cikrik Normal1 |
| 09:40:06 | example |
| 09:41:02 | Cikrik Normal1 |
| 09:41:07 | Cikrik Cok Hizli1 |
| 09:41:10 | play57 |
| 09:42:16 | Disli Cark Normal1 |
| 09:42:18 | Vida Normal1 |
| 09:42:20 | Kama Normal1 |
| 09:42:31 | Vida Normal1 |
| 09:42:33 | Cikrik Normal1 |
| 09:42:54 | Makine Nedir Normal1 |
| 09:43:09 | Makine Nedir Cok Hizli1 |
| 09:43:14 | play2 |
| 09:43:26 | Bas Mak Inc Normal1 |
| 09:43:28 | Basit Mak ile is Yap Normal1 |
| 09:43:35 | Bas Mak Inc Normal1 |
| 09:43:37 | Makine Nedir Normal1 |
| 09:46:19 | Bas Mak Inc Normal1 |
| 09:46:21 | Basit Mak ile is Yap Normal1 |
| 09:46:22 | Neden Mak Kullaniriz Normal1 |
| 09:46:23 | Basit Makine Cesitleri |
| 09:46:24 | Makaralar Normal1 |
| 09:46:25 | Sabit Makara Normal1 |
| 09:46:26 | Hareketli Makara Normal1 |
| 09:46:29 | Makaralar Normal1 |
| 09:46:35 | Makaralar Cok Yavas1 |
| 09:46:39 | play35 |
| 09:47:02 | Sabit Makara Normal1 |
| 09:47:10 | Sabit Makara Cok Hizli1 |
| 09:47:14 | play37 |
| 09:49:06 | Makaralar Normal1 |
| 09:49:08 | Kaldiraclar Normal1 |
| 09:49:12 | PROGRAMDAN ÇIKIŞ |

# APPENDIX H

# INTERVIEW QUOTATIONS

1. "Derste anlatılan konuların görsel olarak bilgisayar ortamında anlatılması, konuları daha kolay anlamamıza yardımcı oldu."
2. "Ben bilgisayarı oyun amacıyla kullanmaya alışkınım. Bu nedenle bilgisayarları eğitim amaçlı kullanma fikrine bir türlü ısınamadım."
3. "Eğitim yazılımındaki görsel-işitsel materyallerle yazılı anlatımlar birbirlerini destekliyordu. Görsel-işitsel özellikler sunan videolar ilgimi çekmesi açısından değerliydiler ve öğrenmek istediğim konular hakkında genel bir fikir verdiler."
4. "Konu içeriklerini istediğim kadar tekrar etme şansım vardı ve bunu diğer yöntemlerle karşılaştırıldığında eğitim yazılımlarının avantajı olarak görüyorum."
5. "Program daha çok etkileşimli alıştırmalar ve testler içermeli."
6. "Menü butonunun olması hoşuma gitti ve sıklıkla kullandım çünkü ünitedeki konulardan istediğimi seçmeme izin verdi."

7. “Programı bilgisayar labında öğretmenimiz bulunurken kullanmayı tercih ederdim. Çünkü bir konuyu programdan öğrenirken herhangi bir zorlukla karşılaştığımda yardımına ihtiyacım olabilir.”
8. “Kullandığımız bu program gerekli bilgileri bize sağlıyordu. Bu yüzden bu programı kullanırken öğretmenimizin yardımına ihtiyacım olmadı. Aslında daha zor konuları öğrenirken öğretmenlerimizin yardımına ihtiyacım olabilir.”
9. “Daha önceden bildiğim konuları tekrar derken ‘çok hızlı’ seçeneğini kullandım.”
10. “Dişli çark gibi zor konuları öğrenirken ‘çok yavaş’ seçeneği ‘normal’ veya hatta öğretmenimizin tahtada konuları anlattığı klasik metodlara göre daha kolay öğrenmeme yardımcı oldu.”
11. “‘Normal’ hız seçeneği bana en uygun olan hızdı. Bü yüzden bu aracı kullanmadım.”
12. “‘Çok yavaş’ hız seçeneğini benim için çok yavaş buldum ve zaman kaybettirici olarak düşünüyorum. Diğer taraftan ‘çok hızlı’ hız seçeneği konuları öğrenmeme hiç yardım edemedi çünkü konuşmaları takip edemedim.”
13. “Böyle bir aracın eğitim yazılımlarına eklenmesi faydalı olur.”
14. “Eğitim yazılımındaki konuları anlatan videolarda konuların yavaş bir şekilde anlatılması konsantrasyonumu artırdı. Hızlı olsaydı bazı ayrıntıları kaçırabilirdim. Aynı zamanda en yavaşı seçtiğim için videoda anlatılan konuları bir defada anlamam mümkün oldu. Böylelikle daha kısa sürede öğrenebildim.”

15. “Ses dosyalarının çalma hızını ayarlamamızı sağlayan aracın tasarımını etkileyici buldum. Kullanımı çok kolaydı. Bu aracı kullanırken herhangi bir zorlukla karşılaşmadım.”

16. “Çalma hızını değiştirdiğimde konuşmanın tekrar baştan başlamasını beklemiyordum. Çalma hızını değiştirdiğimde konuşmanın kaldığım yerden devam etmesi daha iyi olabilirdi.”

17. “Bir slider olması daha iyi olurdu ve bunu kullanarak kendime en uygun olan hızı seçebilirdim.”