

USING COMPUTER NETWORK SIMULATION PROGRAMS:  
EXPLORATION OF STUDENTS' ATTITUDE, MOTIVATION AND LEARNING

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EXPLORATION OF STUDENTS' ATTITUDE, MOTIVATION AND  
LEARNING**

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## ABSTRACT

### USING COMPUTER NETWORK SIMULATION PROGRAMS: EXPLORATION OF STUDENTS' ATTITUDE, MOTIVATION AND LEARNING

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The purpose of this study was to explore students' attitude, motivation and learning in introductory networking courses where a simulation program was used. Basic qualitative research method was utilized to seek answers to the research question. Data was collected by individual interviews, conducted to 12 undergraduate and 5 graduate students from two different computer network courses on introductory networking concepts where a simulation program was utilized. The interview data was transcribed and analyzed through formative content analysis to find out the themes and categories. Analysis of data culminated five main themes with categories. Two of the five themes were related to student attitudes; (1) *goal setting*: information age qualities, professional development and problem solving skills, (2) *learner internal factors*: curiosity and interest. Other two themes were related to student motivation; (3) *Self-confidence*: visuality and manuals and (4) *locus of control*: chance to practice and trial and errors. The last theme was related to learning; (5) *deep understanding*: providing concreteness, learning by applying and visuality. The result of the study showed that participants were commonly driven by their needs and interests so as to

become competent in computer networks and find a job to secure their future. In addition, the simulation programs increased students' motivation and self-confidence in the two classes investigated and helped them learn topics easier and better. The results also indicated that the used simulations were considered quite affordable technology in network course to convey abstract concepts to the students.

**Keywords:** Simulation-based Learning, Computer Network Simulation Program, Motivation, Attitude, Learning

## ÖZ

### BİLGİSAYAR AĞI SİMÜLASYON PROGRAMLARI KULLANIMI: ÖĞRENCİLERİN TUTUM, MOTİVASYON VE ÖĞRENMELERİNİN İNCELENMESİ

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Bu çalışmada başlangıç düzeyindeki ağ temelleri dersinde kullanılan simülasyon programının öğrencilerin tutumları, motivasyonları ve öğrenmeleri üzerindeki etkisinin araştırılması amaçlanmıştır. Araştırma sorusunun cevabını bulmak için nitel bir araştırma yürütülmüştür. Simülasyon programlarının kullanıldığı iki farklı ağ temelleri dersine katılan 12 lisans ve 5 lisansüstü öğrenci ile görüşmeler yürütülmüştür. Veriler derinlemesine analiz edilerek ortak temalar, kavramlar ve ilişkili boyutlar elde edilmiştir. Veri, analizler sonucunda beş tema ve alt kategoriler altında toplanmıştır. Bunlardan iki tanesi tutumla ilgilidir: (1) *hedef belirleme*: bilgi çağı yeterlilikleri, profesyonel gelişim ve problem çözme yeteneği, (2) *öğrenci kaynaklı içsel faktörler*: merak ve ilgi. İki tanesi ise motivasyonla ilgilidir: (3) *özgüven*: görsellik ve örnek uygulamalar, (4) *öğrenme odağı*: uygulama şansı ve deneme – yanılma. Son tema ise öğrenme ile ilgilidir: (5) *derinlemesine öğrenme*: somutluk sağlama, uygulayarak öğrenme ve görsellik. Araştırmanın sonucu gösteriyor ki, katılımcılar ağırlıklı olarak bilgisayar ağları konusunda yeterli olmak ve geleceklerini güvence altına alabilecekleri bir iş bulmak gibi kaygılara sahiptir. Buna

ek olarak, simülasyon programları her iki ağ temelleri sınıfında da öğrencilerin motivasyonunu arttırıp konunun daha kolay ve etkili şekilde anlaşılmasına yardımcı olmuştur. Son olarak, ağ derslerinde soyut kavramların öğretilmesinde simülasyon kullanımının oldukça uygun bir teknoloji olduğu ortaya çıkmıştır.

**Anahtar Kelimeler:** Simülasyon Tabanlı Öğrenme, Bilgisayar Ağı Simülasyonu Programı, Motivasyon, Tutum, Öğrenme.

To my family

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## **LIST OF ABBREVIATIONS**

<b>SBL</b>	Simulation-Based Learning
<b>IP</b>	Internet Protocol
<b>RIP</b>	Routing Information Protocol
<b>OSPF</b>	Open Shortest Path First
<b>TCP/IP</b>	Transmission Control Protocol / Internet Protocol
<b>OSI</b>	Open System Interconnection



## **CHAPTER 1**

### **INTRODUCTION**

The technology provides more options today while learning something new. In today's fast developing global world, people focus on time and cost efficient ways of learning and computer-based instruction methods are what they look for. These methods can provide easier ways both for instructors and students. With the help of technology, the motivation of the learners can be increased and their attitudes can be positively changed towards learning, especially abstract topics.

In this chapter, the background of the study, the purpose of the study, research questions, significance of the study, and definition of terms will be presented. The purpose of this chapter is to provide an overview of the study regarding its topic, study question and its purpose by also providing the basic terms to be used in this study.

#### **1.1 Background of the Study**

As technology advances, the teaching, and learning instruments have also been adapted to the technology. With the increasing use of computer technology especially since the last decade, the use of computer-based instruction methods has become more common. In today's information society, where people now use information in any area possible from economy as consumers to education as learners or instructors, the tools providing information use have also become incredibly important. As a result, computer-based instruction methods, since they provide quick and easy, time and cost efficient ways, have become important in education field.

In such a time, it has become important to learn and instruct. However, people may find some topics harder to learn than others, as abstract topics. Thus, teaching these can also turn into a challenge. However, many topics are abstract in nature and they can be seen as difficult topics to learn by the students (Adeyegbe, 1993; Akpan, 1994; Adzape, 1995). At this point, developing technology according to such needs plays an important role. Hence, one of the main issues in this field is to shed light on what kind of an effect technology can have on students' attitude and motivation towards courses they take. There are various ways of using computer-based instruction as simulation and computer networking and these are also effective in students' motivation and attitudes in a positive way.

Simulation is one of the most important technologic developments of the modern time. For the past two decades, instructional technologists have been projecting that real life simulation would have a great impact on education (Thomas & Hooper, 1991; Dede, 1992; Hardin & Ziebarth, 2000). In a multimedia based learning environment, computer simulations have a great importance because they offer a high potential for interactive learning (Yaman & Nerdel & Bayrhuber 2008). According to de Jong and van Joolingen (1998) a computer simulation is "a program that contains a model of a system (natural or artificial; e.g., equipment) or a process." There are many simulation tools for different fields. The computer networks are also simulated on computers. Networks simulators allow students to manage computer networks labs like a real laboratory environment.

Computer networking is main research area in the computer engineering (Surma, 2003). Computer networks have a critical role so as to establish connection and share resources in a specific domain because of rapid changes and developments on the information and communication technologies. Research on teaching and learning of computer networks is an essential part of the information technology and instructional technology fields.

Using simulation is very common in the computer networks because of its flexibility and availability. Bello, Mirebella & Raucea (2007), used a web-based test bed that included basic components of computer networks like router, hub, and switch so as to enable students to perform practical application of computer networks. In addition, Goyal, Lai, Jain, & Durresi (1998), developed a simulation environment for computer networks and telecommunications. According to Winters, Ausanka-Cruces, Kegel, Shimshock, Turner, & Erlinger, (2006) a simulation platform named TinkerNet was developed so that students can their own networking study related with Ethernet, TCP and UDP.

Motivation is another important factor for students' success in courses. Using media can be very effective to motivate students in courses, which have many abstract topics. Media and situations should be used to teach abstract concepts (Theobald, 2005, p. 84). In computer network courses, which include many abstract topic and protocols, motivating students is a big problem. According to Zheng (2015, p. 30), computer networks concepts and protocols are very abstract and boring for students. An interactive learning experience, which gives students the opportunity to control their own learning and a chance to have hands-on experiences with subject-matter, is supportive of high-level student learning as well as mastery of practical skills. In terms of computer network courses, this interactive learning experience can be provided via computer simulations (Urhahne & Harms, 2006). Another important factor is the attitude of the students towards computer network course since attitude is the key to success. According to the studies in educational field, it is seen that student attitudes towards a subject lead to academic success (Popham, 2005; Royster, Harris, & Schoeps, 1999).

As briefly stated above, using computer-based instruction methods via simulation and computer networking will provide the students better motivation and attitude for learning. This basic notion stands as the background of the study.

## **1.2 Statement of Problem**

Because of their content with many details and protocols in abstract nature, computer network is a challenging area to teach. A common problem faced by learners in networking courses is having difficulty on grasping protocols and abstract topics of a computer networking systems. Students are expected to acquire both theoretical knowledge and practical skills during their computer network courses so as to manage real computer networks scenarios (Ruiz-Martinez, Pereniguez-Garcia, Marin-Lopez, Ruiz-Martinez, & Skarmeta-Gomez, 2013). Nevertheless, gaining practical skills is challenging especially in the classic classroom environments. To overcome this challenge, students need a real laboratory environment to master practical skills associated with computer networking. Nonetheless, despite their positive effects on students in terms of gaining practical skills of computer networking, real laboratory environments are hard and expensive to build. Virtual laboratories, on the other hand, are alternatives to real laboratories that can help students to master practical skills they need to acquire without having shortcomings of real time laboratories. Virtual laboratories can help making crucial educational applications available to students (Kumar, Pakala, Ragade, & Wong, 1998; Shin, Yoon, Park & Lee, 2000; Grob, 2002; Jeschke, Richter, & Zorn, 2010). Virtual laboratories convert students' theoretical knowledge into practical knowledge by simulating real laboratory environment (Woodfield, 2005).

Although there are many study in the literature related with the use of simulation program on computer network course, there are not enough studies about how simulation programs affect students attitude, motivation, and learning in the course. By conducting this study, students' thoughts and perceptions about the effect of using simulation programs on their learning, attitude and motivation will be revealed.

### **1.3 Purpose of the Study**

The purpose of this study is to investigate effects of the computer network simulation program on students' attitude, motivation and learning towards computer network courses. Two introductory computer-networking courses, a workshop offered as free extra-curricular course and a well-known certificate exam preparation course utilizing networking simulators will be investigated through the study. In doing so, three research questions will guide the study:

#### Research Questions

1. How did using the computer network simulation program affect students' attitude towards the course content?
2. How did using the computer network simulation program affect students' motivation in the computer network course?
3. What were students' perceptions about the effect of using a computer network simulation program to learning the course content?

### **1.4 Significance of the Study**

It is expected that the results of this study will yield valuable information about the use of networking simulators in teaching-learning introductory networking topics. Effects of the program on students' attitude, motivation and learning towards computer network course will be investigated through students opinions and perceptions.

Computer networks courses are a rather challenging in nature since they require students to master many abstract topics and protocols. For this reason, it may be difficult to motivate students towards computer network courses. Simulations may have great positive effects on fostering student learning as well as on having positive attitudes towards computer network course, which in turn may increase student learning, and increase student motivation. This study may contribute to literature by

revealing valuable information on effects of simulations on computer networks courses, especially on student attitude, motivation and learning.

Computer Network Simulation tools are sometimes more effective than physical devices because they simulate some abstraction that physical devices cannot. OSI and TCP/IP models are difficult for students because they cannot see network layers by using physical devices. However, using a simulator, students can see the function of all layers and their processes and how header end trailer is added and removed during the transportation of packet between different networks.

In addition, this study may also provide helpful information to computer networking simulation developers in redesign their products in light of findings of this study. Moreover, educators specializing on teaching of computer network courses may use the findings of this study for betterment of their students' experience within their courses via simulation laboratories.

### **1.5 Definition of Terms**

**Simulation:** “The process of designing a model of a real system and conducting experiments with this model for the purpose either or understanding the behavior of the system or of evaluating various strategies (within the limits imposed by a criterion or set of criteria) for the operation of the system” (Shannon, 1975).

**Simulation-based Learning:** “Reproduction of some aspect of reality ... [to] better understand, manipulate or predict real behaviour” (Kneebone & Nestel, 2005, p. 86).

**Computer Network:** is connection of computers with various ways which are independent of one another or need each other to be functional so as to share resources information and ensure communication between people (Baykal, 2005, p. 21).

**Network Simulation:** “is the implementation of a simulation that attempts to imitate the real world behavior of a computer network or certain aspects of a computer network to analyze the captured information and transmitted data” (Rampfl, 2013).

**Motivation:** “the attribute that moves us to do or not to do something” (Broussard and Garrison 2004, p. 106).

**Attitude:** "a mental and neural state of readiness, organized through experience, exerting a directive and dynamic influence upon the individual's response to all objects and situations with which it is related" (Allport, 1935, p. 810).

**Learning:** is "a relatively permanent change in behavior based on an individual's interactional experience with its environment" (Ray et al., 2005, p. 10).



## **CHAPTER 2**

### **LITERATURE REVIEW**

There are many questions on the relation of the educational settings and educational outcomes. Two of these questions considered as very important are:

- Does a classroom environment affect students learning and attitude?
- What are the factors affecting the students' learning?

These questions are the results of years' study and experience, which show that learners are largely affected by the learning environment and methods. This study, as stated before, investigates the computer-bases instruction methods affects on learning, attitude and motivation and thus, the literature questioning the abovementioned issues are important to share for the purpose of this study.

With the development of various technology enhanced learning environments, educational researchers started to explore these questions. Earlier studies claimed that the use of technology in education can change schools and improve education (Bracewell et al., 1998; Means and Olson, 1995; Wengliniski, 1998).

Technology can be used in many different ways to support to learning. Digital gaming and simulations are two of these technologies. Digital games in the classrooms provide students a purposeful and funny learning environment. Digital gaming is "Purposeful, goal-oriented, rule-based activity that the players perceive as fun" (Klopfer, 2008). Also simulations as a technology tool to support the learning enable students to model real world situations in classroom. Simulations are "analog[ies] of a real world situation[s]" (Prensky, 2001, p. 128).

In computer network courses, the combination of face to face, simulation based and online learning environments are used frequently. In most of the computer network course there appear five components. These are online content, multimedia components, online assessment, lab activities, and network simulation software. Computer network course can be given face to face or blended where different media are integrated into classroom instruction are called blended learning environment. The important point is to distinguish blended-learning from other forms of learning. The blended-learning is the effective integration of face to face and internet technology. There are different definitions for blended learning in the literature. Blended learning environment is defined as a combination of face to face and online learning environments so as to use the strongest part of both them (Delialioğlu & Yildirim, 2007; Osguthorpe & Graham, 2003).

In the study of Zhi and Ya (2013), they prepared an inquiry-based network simulation learning system for the computer network course. The results of the study showed that in inquiry-based learning system, students' interest of learning has been greater than traditional instruction.

Graven, Hassen and Mackinnon (2009) made a study related with the routing topic in computer network course. The purpose of researchers was to show the viability of using a specifically designed computer game to integrate abstract learning materials as a part of blended learning environment. The result of the study showed that thought that they learned just as much in specifically designed platform from a traditional lecture and lab. Also, the platform increased the motivation of students towards topic.

Motivation is often thought as a necessary processor for the learning (Gottfried, 1985; Lepper, Iyengar, & Corpus, 2005). Literature supports the idea that motivated students spend more time and effort in learning and they are more persistent so as to complete challenging tasks (Malone, 1981; Stipek, 1993).

Motivation is an important driving force both for teaching and learning. Educational psychologists have emphasized the importance of motivation for students learning for a long time (Ames, 1990). There are many definitions of motivation in the literature.

“the reasons underlying behavior” (Guay et al., 2010, p. 712).

“the attribute that moves us to do or not to do something” (Broussard and Garrison 2004, p. 106).

Two types of motivation are intrinsic and extrinsic motivation.

“Intrinsic motivation energizes and sustains activities through the spontaneous satisfactions inherent in effective volitional action. It is manifest in behaviors such as play, exploration, and challenge seeking that people often do for external rewards” (Deci et al., 1999, p. 658).

“Extrinsic motivation is a construct that pertains whenever an activity is done in order to attain some separable outcome. Extrinsic motivation thus contrasts with intrinsic motivation, which refers to doing an activity simply for the enjoyment of the activity itself, rather than its instrumental value” (Ryan and Deci, 2000).

Intrinsic motivation is more common in the educational field than extrinsic motivation. According to the study of Deci et al. (1999), educators think that intrinsic motivation is more desirable and it enables better learning outcomes than extrinsic motivation. It depends on the individual rather than external factors and this can be stated as one of the reasons why intrinsic motivation is more applicable for the education area.

Motivation does not mean much unless it lasts for a long time, as long as the learning period if possible. To provide a continuing motivation, there are some models structured. One of them is the ARCS Model of Motivational Design, which ensures the continuity of the motivation to learn. According to the ARCS Model, instructional materials should be configured with some strategies like (A) Attention, (R)

Relevance, (C) Confidence and (S) Satisfaction (Keller, 1983; Keller & Kopp, 1987).

ARCS Model identifies four essential strategies for motivation:

- (A) Attention is the first component of the model. Getting students' attentions, setting in motion their curiosity, and engaging the through the instruction are concern of attention strategies (Keller, 2008). According to Keller (1983), getting attention is relatively easy than sustaining it during the instruction.
- (R) Relevance strategy is related with learners' interests, needs, and motives. Students feel relevant when the instruction offer opportunities so as to satisfy learners' needs. Teaching practices enabling to establish link between students' goals, learning styles, prior experiences, and the instructional environment are useful for building relevance (Keller, 2008).
- (C) Confidence strategy helps students develop positive expectation for achievement. People with confidence liable to accomplish their goals through their actions (Bandura, 1977; Bandura & Schunk, 1981).
- (S) This category helps people to feel good about their accomplishments. According to reinforcement theory, when task and reward are defined, people should be more motivated (Keller, 1987a). Feedback and reinforcement are important elements for motivation. When learners were satisfied from the results, they will be motivated to learn. Satisfaction strategy provides extrinsic and intrinsic reinforcement (Keller, 1983). Details were given table 4.2.

As a result, these four categories form the basis of ARCS Model. There are some subcomponents of ARCS Model components (Keller, 1987a). These components were given below in table 2.1.

**Table 2.1** ARCS Model: Subcategories and strategies under each category (Keller, 1987a, p. 4-5).

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<b>Attention Strategies</b>
<b>A2: Concreteness</b>
<b>A2.1</b> Show visual representations of any important object or of set of ideas or relationships.
<b>A2.2</b> Give examples of every instructionally important concept or principle.
<b>A2.3</b> Use content-related anecdotes, case studies, biographies, etc.
<b>Relevance Strategies</b>
<b>R6 Choice</b>
<b>R6.1</b> Provide meaningful alternative methods for accomplishing a goal.
<b>R6.2</b> Provide personal choices for organizing one's work.
<b>Confidence Strategies</b>
<b>C5 Self-confidence</b>
<b>C5.1</b> Allow students opportunity to become increasingly independent in learning and practicing a skill.
<b>C5.2</b> Have students learn new skills under low risk conditions, but practice performance of well-learned tasks under realistic conditions.
<b>C5.3</b> Help students understand that the pursuit of excellence does not mean that anything short of perfection is failure; learn to feel good about genuine accomplishment.
<b>Satisfaction Strategies</b>
<b>S1 Natural Consequences</b>
<b>S1.1</b> Allow a student use a newly acquired skill in a realistic setting as soon as possible.

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Table 2.1 shows ARCS Model subcategories and strategies under each category.

There are many studies related with the ARCS Model. In the study of Malik (2014), the effectiveness of ARCS Model to overcome the motivational obstacle of distance learning was discussed. According to the results of the study, distance organization can use ARCS Model so that student can motivate to complete the course. Also, ARCS Model helps organizations to overcome low motivational problems of the distance learners.

Ocak and Akçayır (2013), studied whether Keller's ARCS Model increased academic performance and the motivational level of students. The participants of the study were 90 first year college students who were randomly assigned to treatment and control groups. While treatment group used systematically designed motivation tactics based on Keller's ARCS Model, the control groups did not use motivation tactics in the Basic Computer II lessons. In the experimental study, all subscale score of the treatment group were higher than the scores of control group with regard to learner motivation and academic achievement. The results of the study showed that ARCS Model has a positive effect to a blended learning environment and the use of the model increased students' motivation and academic achievement.

Hu (2008) investigates in his study how usability improvement and motivational design affect learners' motivation and learning performance in an online learning environment. 72 college students (48 males and 24 females) participated to study. Two alternative designs named Phase I and Phase II were developed based on ARCS Model. In Phase I, three interfaces named B, U and UM were developed. Interface B was a self-paced online safety training tutorial. Interface U improved after the evaluation of interface B and interface UM was developed after motivational design applied to interface U. These interfaces were used in the experiment in Phase II. In the study, Keller's ARCS Model was used so as to measure motivation. The results of the study showed that when usability improvement and motivational design used together, it can positively affect learners' motivation in a self-paced online learning environment.

Another study by Astleitner and Koller (2006) on motivation, aims at identifying differences in motivation levels in different types of multimedia-based methods. A total of 68 students who were 8<sup>th</sup> grade (46 male and 22 female) participated to an experiment. Four types of multimedia-based instructional system were implemented to test theoretical assumptions in the study. One of the system had no ARCS Model strategies, one had attention strategies, another had relevance strategies and final system had both attention and relevance strategies. According to the results of study, the combination of two ARCS components which are attention and relevance strategies improved students' motivation to learn. Also the study showed that attention and relevance strategies were very effective on students with low level of pre-motivation.

As stated before, simulation is an important technologic development and it is very much related with attitude and motivation. In another study, simulation is examined by Aycan et al. (2002) regarding its effect on students' achievement in a physics course. The name of the topic was "Motion in one Dimension" which was considered as a difficult topic for the students. A total of 222 students from Faculty of Education participated in the study. The research found that students who used simulation had better ability to define the subject and their comments were more reasonable than control group. The research observed that the experimental group using the simulations was more successful than control group.

Literature shows that computer simulation programs had an effect on the motivation of the students. When used in educational settings, these tools could increase students' motivation to learn. Petranek et al. (1992) stated that games and simulations excite students and increase their motivation to learn.

Akkağıt and Tekin (2012) conducted a study to see the effect of the simulation-based education on the secondary school students' achievement in the course of basic

electronics and measurement. The study was conducted with 30 tenth-grade students from Palu Vocational and Technical Education Center. The result of the study shows that simulation based education increased students' achievement level, students' level of understanding and motivation. According to the results of the research of Kranjc (2011), simulation program attracted the interest and attention of the students.

In their study, Garard et al. (1998) with the 90 undergraduate students enrolled in speech communication courses at Midwestern University found that there were significant differences in students' motivation according to types of instruction received. The research showed that students who study with the game and simulation activities during the lesson are more interested and motivated.

## **2.1 Attitude**

There are many variants affecting the success in education. Attitude of students towards the subject, school, teacher and similar items are some of these variants (Açıkgöz, 1992). Many definition of attitude can be found in the literature. According to Tezbaşaran (1997), attitude is a learned tendency of positive or negative reaction towards a particular object, situation, establishment, concept, or people. As stated by Allport (1935), explains attitude as a directing and driving sign of an individual's response to related topics or objects with an experienced mental or neural state towards these situations. Similarly, Eagly and Chaiken state that attitude is "a psychological tendency" which is revealed through the evaluation of certain cases "with some degree of favor or disfavor" (Eagly & Chaiken, 1993, p. 1).

Positive attitude towards the course is important since attitude affects the students' success. Hendricks (1997) stated that motivation and attitude is the key point for the achievement of the students. Zimmerman, Bandura, and Martinez-Pons (1992) also observed in their study a positive significant correlation between students' attitude and academic achievement.

In their study Bakar et al. (2010), tried to investigate relationship between university students' achievement motivation, attitude and academic performance in Malaysia. In the study, there were 1484 students from a local university. The results of the study showed that there was a positive correlation between the students' attitude and academic achievement.

According to Anderson (1994), there are five components of attitude that are emotion, goal, direction, strength and consistency. There are many model related with the attitude. ABC model is one of the most useful attitude models (Eagly & Chaiken, 1998). In this study, the ABC Model was used. According to ABC Model, attitude has three elements which are Affective, Behavior, and Cognition. Table 4.2 shows the components of attitude. Affective shows the students' interest. According to affective component, an individual's attitude towards an object cannot be determined only by identifying its beliefs about something. A person's feeling and emotions play an important role on attitude. According to Agarwal & Malhotra (2005), feeling, emotions and attitude are combined so as to propose an integrated model of attitude. Behavior is another component of attitude. According to Wicker (1969), behavioral tendency of an individual consists of actions and observable responses that are the result of attitude object. Behavioral intension is related with the people's goals and intentions to act in a specific way. Goal is one of these components of attitude. Goal setting provide a positive contribution to the development of positive attitude (Bennett as cited in Demir, 2002; Demir, 2002).

**Table 2.2** Components of Attitude

<b>Affective</b>	Emotional or feeling segment of an attitude.
<b>Behavioral</b>	An intention to behave in a certain way.
<b>Cognitive</b>	Opinion or belief segment of an attitude.

Table 2.2 shows the components of attitude and their brief description.

Ashaari et al. (2011) investigates students' attitude towards a statistic subject. In the study there were six factors contributing the study, which are affective factor, cognitive capability, difficulty, value, interest and students' effort. The results of the study showed that some of the students showed negative attitude towards the course since students think that the statistic course is not related their field of study and their future career and professional life. It was found that some students showed positive attitude because of their interest to the content.

In his study, Özdemir (2012) evaluated students' attitude toward secondary education geography lesson. According to the results of the study, students have positive attitudes and thoughts towards the course because of benefits of geography lesson. Many of the students stated that they have interest to the natural disaster and other environmental problems. Also students want to improve skills for evaluating natural events. For this reason, they have a positive attitude towards the geography course.

Students with positive attitude towards the course show a high performance in the course (Schreiber, 2000). Besides, it was indicated that there was a significant correlation between attitude towards course and the achievement of the students (Papanastasiou, 2002). However, it cannot be said that positive attitude always cause high achievement. According to study of Kiely (1990), a small number of students who were not good in mathematics obtained high scores in the attitude test.

There are several research studies on the factors improving students' positive attitude towards the content. Some of these factors affecting attitude of students towards the course is the computer simulation programs. In their study Chen and Howard (2010) examined effects of simulation on students' science learning and attitude. A total of 311 middle school students participated to the study. A pre-test post-test design used before and after usage of simulation in the study. The findings of the study revealed use of simulation in the science education cause positive changes in students' attitudes and perception towards scientists.

In his study Tüysüz (2010) prepared a virtual laboratory related with “Separation of Matter” unit for the 9<sup>th</sup> grade students so as to investigate virtual laboratory effects on students’ achievement and attitudes. In the study, 16 experiments developed by using flash program. Experimental group used virtual laboratories while control group used neither virtual laboratory nor any real-lab equipment. The results of the study showed that virtual laboratory applications made positive effects on students’ achievements and attitudes when compared to the traditional teaching methods.

Shegog et al.(2012) studied the impact of the Molecular Biology Simulation on students’ academic achievement and attitudes. The participants of the study were 44 high school biology students from Mercedes, Texas. The study found that simulation increased students’ procedural and declarative knowledge. However, the simulation did not significantly affect attitudes towards science in general.

## **2.2 Simulation-Based Learning**

As technology advances, computer-based instruction methods become popular in education. Simulation-based learning is an important method in computer-based instruction. Simulation based learning is defined as follows: “Reproduction of some aspect of reality ... [to] better understand, manipulate or predict real behaviour” (Kneebone & Nestel, 2005, p. 86).

To briefly explain the simulation as a definition, Shannon (1975) states that simulation is the design process of a model of “a real system” and to carry out some experiments using this model with this model. The purpose here, as stated by Shannon (1975) is to “understand the behavior of the system” or to “evaluate various strategies (within the limits imposed by a criterion or set of criteria) for the operation of the system”.

Simulation programs are one of the computer aided instruction applications that are powerful and potentially valuable (Price, 1991). Educational simulations present an

interactive and representational environment that provides an effective learning for students (Aldrich, 2005, p. 270). According to Bransford, Brown and Cocking (2000) high-level learning can be achieved when students construct their own understanding of scientific knowledge within existing knowledge framework. So as to accomplish this objective, students can use computer simulation software (Wieman, Adams & Perkins, 2008). Simulation software can help students to get a deep understanding of knowledge by enabling repeating manipulation and observation. According to Zacharia and Olympiou (2011), simulation environments help students to get a greater understanding of domain knowledge.

Simulation software provides students a platform like real world context. Computer based simulation provides opportunities to practice the solving of real-world problems so as to meet the needs of learners (Jonassen, 1996). Usually students cannot address these problems in real-world environments because of some limitations like time, risk and lack of money. However, there are no limitations in the simulation software (Dennis & Kansky, 1984). Simulation programs are particularly valuable tools since they demonstrate the changes in simulation platform before they are applied in the real world (Marks, 1982). Computer simulations enable students to create a form of virtual reality, and virtual reality allows students learn and apply knowledge and skills related with the professional jobs (Bell et al., 2008).

In simulation-based learning, understanding and defining problem is important. According to Hallinger and Bridges (2007) and Gary and Wood (2011), so as to succeed in simulation, students must understand and define the problem(s) and they must consider practical skills as well as theoretical knowledge.

Simulation programs provide students a visual representation. Visualization increase learning performance and it enables students to get a higher cognitive level (Ainsworth, 2006). With visual representation, students learn easily. Visual representations help students construct mental models of natural phenomena (Gilbert, Boulter, & Elmer, 2000; Gilbert & Priest, 1997; Renk, Branch, & Chang, 1993). A

mental model symbolizes an individual's real worldview. A mental model includes such questions as "how thing works, how problems can be solved" (Carroll & Olson, 1987; Holland, 1986; Johnson-Laird, 1993). Visual representations enhance the overall affects and results related with the learning process.

Simulation-based learning environments are obvious, rational and efficient learning environment for the conceptual learning. According to the literature, computer simulation is a conceptual learning environment that enables students to learn easily abstract topics by supporting observation and reflection activities (Chen, Hong, Sung, & Chang, 2011; Mzoughi, Foley, Herring, Morris, & Wyser, 2005; Dori, Barak, & Adir, 2003; Papaevripidou, Hadjiagapiou, & Constantinou, 2005).

Simulation-based learning environments are appropriate for the discovery learning. Students must explore and discover information by speaking in a simulated realistic setting (de Jong & van Joolingen, 1998). According to Smith and Boyer (1996: 690) 'Simulations have the power to recreate complex, dynamic political processes in the classroom, allowing students to examine the motivations, behavioral constraints, resources and interactions among institutional actors'. Also simulation-based learning helps students to participate in lessons. Simulations increase students' participation and satisfaction when it is compared with lecture-seminar format (Henley 1993).

Tatli and Ayas (2013) examined the effects of virtual chemistry laboratory on students' achievement in order to address importance of laboratory applications in chemistry education. The participants of the study were 90 students from three different ninth grade classrooms. According to the result of the study, virtual chemistry laboratory software is at least as effective as the real laboratory in terms of the students' achievements and the ability of recognizing laboratory tools.

Virtual laboratories are important especially in science classes. Herga, Grmek and Dinevski (2014) conducted a study to determine the importance of virtual laboratory as visualization tools while addressing chemical contents in science classes. In the study, there are 109 seventh grade students from five different schools. Also this study tried to answer the question whether virtual laboratories had positive effect on learning outcomes of the students or not. The results of the study showed that in terms of the obtaining information, the classes with the virtual laboratories were more effective than the classes without virtual laboratory.

Bayrak (2008) investigates whether the computer based instruction or face-to-face instruction is more effective on student success in Physics. The participants of the study were seventy-eight freshman students from Department of Science and Mathematics for Secondary Education at Hacettepe University. According to the results of the study, students who had instruction with the computer simulation were more successful than the students who had face-to-face instruction.

Another study on the contribution of simulation was conducted by Mhlongo, Kriek and Basson (2011), assessing the contribution of simulations on physics students' practical work. In the study, there are 20 physics students from University of Limpopo and two test "Determining and interpreting resistive electric circuits concepts test" and the "Test of integrated science process skills" were used. Observation sheets, worksheets and a class test were used so as to gather data. Also, interviews with the selected students were conducted. According to the results of study, simulations had a positive effect on students' understanding of electric circuits. However, it was also found in the study that there is no difference between the students who used simulations and others who did not use simulations with regards to the development of process skills.

Jimioyiannis and Komis (2001) examined the role of computer simulations in the development of functional understanding of the concepts of velocity and acceleration

in projectile motions. In this study, two groups (control and experimental) of 15 and 16 years old participants were studied and both groups received traditional instruction. In addition, experimental group also used simulation program, which was related to velocity and acceleration. The results showed that students working with simulation had significantly higher scores.

Huppert, Lomask & Lazarowitz (2002) investigated a computer simulations' impact on students' academic achievement in their study named "Computer simulations in the high school: Students' cognitive stages, science process skills and academic achievement in microbiology". The simulation program was related to the concept of 'The Growth Curve of Microorganisms'. The participants of the study were tenth grade biology students. The results of the study indicate that students in the experimental group had significantly higher academic achievement than students in the control group.

### **2.3 Computer Network Simulation**

Specialized network laboratories are vital for the computer network courses. According to Alnoukari, Shafaamry and Aytouni (2013) teaching concepts, protocols, design and applications of computer network at colleges and universities are problematic without having specialized laboratories. However, real network laboratories are very expensive and they are not proper for the various network topologies. Also real laboratory platforms can be used only a small number of students due to physical limitations (Alnoukari, Shafaamry and Aytouni, 2013).

At this point, computer network simulation provides solutions. Computer network simulator can help students to build complex networks. Network simulation is low-cost and easy to use. Network simulation could be used for teaching IP addressing static and dynamic routing like RIP and OSPF (Baumgartner, Braun, Kurt & Weyland, 2003).

Network simulators provide many advantages. For example they are fast and inexpensive. While setting up a network environment including multiple networked computers, routers and data links, network simulators are relatively fast and inexpensive in terms of cost and time (Potemans, Theunis, Rodiers, Van den Broeck, Ley, Van Lil, & Van de Capelle, 2002).

There are many network simulators used in different networking courses. Some of them are listed below:

*NetSim*: Is a network simulator used for simulation and modelling of various network protocols like WLANs, Ethernet, TCP/IP, and asynchronous transfer mode (ATM) switches (Tetcos, 2011). NetSim is proper for a variety of operating systems. However, the use of NetSim in academic environment is limited.

*CNet*: Was developed for undergraduate computer network courses in 1991 by Chris McDonald at University of Western Australia. Since then, it has been used by thousands of students worldwide. CNet simulation tool enable experiments with data link layer, network layer, and routing and transport layer networking protocols (Csse.uwa.edu.au, 2015).

*Cisco Packet Tracer*: Is a network simulation program that allows students to experiment network behavior. Packet tracer allows students to create a network with an almost unlimited number of network devices. Packet Tracer provides simulation, visualization and it facilitates teaching and learning of complex technology concepts (Netacad.com, 2015).

*Huawei eNSP*: Enterprise Network Simulation Platform (eNSP) is a free network simulator tool developed by the Huawei so as to simulate Huawei routers, switches and large-scaled networks (Enterprise.huawei.com, 2015).

## **2.4 Summary**

The literature shows that how simulation-based learning affect students' attitude motivation and learning towards the course. Some studies in the literature indicate that computer simulations cause students to exhibit a positive attitude towards the course. In addition to this, it is seen in the literature; students have high motivation in simulation-based learning environments. Lastly, how computer simulations affect students learning discussed in the literature. Literature shows that students' academic achievement increase in simulation-based learning environments. Many of the studies related with the computer simulations in the literature was made in science, biology and chemistry courses. However, the number of the studies related with simulation programs' effect on students' attitude, motivation and learning towards the computer network courses is very limited.



## **CHAPTER 3**

### **METHODOLOGY**

This chapter provides detailed information about the research regarding its design and implementation. Within this chapter, the research questions, research design, participants, context, data analysis, data collection instruments, and assumptions are presented.

Many computer network courses have been designed for both graduate and undergraduate levels. Although students learn various computer networks concepts in these traditional courses, they need to practice with the real network devices so that they can deeply understand the network topics. Many of the universities are currently studying with classical physical networking labs (Comer, 2002). In spite of the usefulness of such labs in teaching, they have some shortcomings like security, cost, and flexibility.

At this point, computer network simulation program is an alternative way of teaching computer networks. This approach may be very useful since it is efficient to simulate both small and large networks with different technologies and topologies without security, cost, and flexibility shortcomings. Although simulation program is very efficient to simulate computer networks, there is a question how it affects students attitude, motivation and learning of students. So the aim of this research is to investigate the effect of computer network simulation programs on students' attitude, motivation and learning in two computer network courses covering introductory networking topics.

### 3.1 Research Design

In this study a qualitative research design was preferred so as to get a wide thought of participants about effects of computer networks program on participants' attitude, motivation and learning. The purpose of using a qualitative research design in this research is to provide a wide insight of the participants' values and beliefs. Hoepfl (1997) expresses five basic characteristics of the qualitative research as below:

1. In qualitative research, the natural setting is used as the source of data. Settings are observed by the researcher so as to observe, describe, and interpret as they are.
2. The researcher sees the human as the instrument of the data collection.
3. Inductive data analysis used predominantly by the qualitative researchers.
4. Qualitative research reports are descriptive and they are incorporating expressive language and presence of the voice in the text.
5. Qualitative research has an interpretive character. In qualitative research, it is aimed to discover the meanings of the events for individuals who experience them. Also, it is aimed to discover the interpretations of these meanings by the researcher.

Also according to the Fraenkel, Wallen and Hyun (2012), the basic assumptions of qualitative research are:

1. Participants in the study create meaning on their own,
2. Research studies offer alternative interpretations,
3. Researcher is a part of process,
4. Values and facts are associated with each other,
5. There is no generalization in qualitative research.

Qualitative method in exploratory research has some advantages. First of all, participants have the opportunity to answer open ended questions with their own words instead of choosing them from fixed responses as quantitative methods do.

Secondly, qualitative method gives chance to the researcher so as to probe initial participants' responses by asking how or why (Mack et al., 2005, p4).

The design of the study is a basic qualitative research design. According to the Merriam (2009), the characteristics of basic qualitative research are as follows:

1. How participants commend their experiences,
2. How participants build their worlds,
3. How participants assign meanings to their experiences

As clearly described in aforementioned sentences qualitative research design is employed to explore different aspects of experiences of students on a phenomena. Since this study aimed to investigate students' thoughts about the effect of simulation program on their attitude, motivation and learning towards the computer network course, use of basic characteristics of qualitative research, is suitable in order to reach the aims intended in this study.

### **3.1 Research Question**

The main purpose of this study is to understand how computer networks simulation program effect students' attitude, motivation, and learning towards the course.

The research questions in line with the purpose of the study are as follows:

1. How did using the computer network simulation program effect students' attitude towards the course content?
2. How did using the computer network simulation program effect students' motivation in the computer network course?
3. What were students' perceptions about the effect of using computer network simulation program to learning the course content?

### **3.2 Participants of the study**

The participants of this study were students who took two computer networks courses at the 2014-2015 fall semesters at Middle East Technical University (METU) Ankara, Turkey. The participants were selected from the two different courses. One of the courses was a 20 week long workshop offered as free extra-curricular course to 1<sup>st</sup> to 4<sup>th</sup> grade students of all departments at METU. The second course was a 5 month long commercially well-known certificate exam preparation course. The students of the second course were undergraduate, graduate students and professionals from networking industry. A total of 17 students agreed to participate in the study from two courses. There were 10 participants from the first course and 7 participants from the second course.

The participants were interviewed individually. Participation to this study was voluntary and participants were asked to sign a consent form before the interview. All the participants were informed about the study and they were could ask questions about the study before the interviews. During the interview, participants explained their opinions and perceptions about how the simulation program they used effect their attitude, motivation and learning in the course.

#### **3.2.1 Sampling Technique**

Data were collected from two different computer network courses. Both of these courses had similar course content and instructional design. The main reason for using two courses was that the participants were easily accessible with the help a sampling technique known as convenience sampling. Put another way, I used convenience sampling, a nonprobability sampling technique, in this study. Battaglia (2008) defines convenience sampling as “type of nonprobability sampling in which people are sampled simply because they are ‘convenient’ sources of data for researchers.” In addition, Marshall (1996) further states that using convenient

sampling in qualitative studies may provide many advantages such as cost-efficiency, time-efficiency, and effective results with less effort. As understood from abovementioned studies, the advantages that convenience sampling offers qualitative researchers can be put as follows:

- It provides simplicity to sampling process and thus enables easiness of research,
- It helps data collection process to be done in a short duration of time,
- It is cost effective.

Owing to obvious upsides of convenience sampling, I chose participants of two aforementioned courses since they were easily accessible. By using convenience sampling, I was able to reduce time and cost in data collection process, which let me to study phenomenon I was interested in, more explicitly and exhaustively. Furthermore, according to Saumure and Given Lisa (2008), convenience sampling is studying a population, which is easily accessible to the researcher. Convenience sampling has been employed in many different qualitative studies.

Although convenience sampling provides many advantages to qualitative inquiry process, there are some disadvantages of it that qualitative researchers need to be aware of. For example, since the participants studied with convenience sampling technique is not randomly chosen, there is a risk of not being able to generalize the conclusions drawn as a result of the study. However, it should be borne in mind that I did not aim to generalize my results of this study at the first place since qualitative researchers aim not to generalize their conclusions; rather, they aim to understand the phenomenon at hand with interactions with participants who are related to that particular phenomenon. Therefore, convenience sampling served as an appropriate tool of sampling process for my study because of its advantages.

**Table 3.1** Characteristics of Participants

		<b>Age</b>	<b>Gender</b>	<b>University</b>	<b>Grade</b>
<b>Course 1</b>	1	21	M	Undergraduate student	1
	2	18	M	Undergraduate student	2
	3	18	M	Undergraduate student	English Preparation
	4	23	M	Undergraduate student	4
	5	23	M	Undergraduate student	4
	6	24	M	Undergraduate student	4
	7	22	F	Undergraduate student	2
	8	22	F	Undergraduate student	1
	9	21	F	Undergraduate student	4
	10	24	M	Undergraduate student	2
<b>Course 2</b>	11	32	F	Graduate student	M.Sc.
	12	25	M	Graduate student	M.Sc.
	13	29	M	Graduate student	M.Sc.
	14	23	F	Undergraduate student	3
	15	24	M	Undergraduate student	3
	16	26	M	Graduate student	M.Sc.
	17	37	F	Graduate student	M.Sc.

Table 3.1 gives age, gender, university, and grade information of participants.

### 3.3 Context

During the study, the data was collected from two similar introductory network courses. Courses are coded as named course 1 and course 2 during the remaining

explanations. The main goal of both courses was to present information about entry-level computer networks topics like OSI Reference Model, TCP/IP Model, data communication, network devices, and routing. The content of the courses was given in table 3.2 below. Both of the courses consisted of two parts which are lecturing and laboratory part. In addition, courses have online platform including course materials. During the lecturing parts of the courses, the related topics were presented with the help of the text and visual components. In the laboratory part, students gain experience by using real network devices.

Lecturing parts of the courses carried out computer laboratory and there were twenty five computers for students. Placement of the computers in the laboratory was in U-shaped and all of the computers connected to the internet. During the lecturing part, students also used simulation program. The purpose of the simulation program in the courses is to practice immediately what they learn in the course.

**Table 3.2** Explanation of the Content of the Courses

Course - 1	Course - 2
<ul style="list-style-type: none"> <li>• Introduction to Data Communications</li> <li>• Network Concept</li> <li>• Types of Communication and Signaling</li> <li>• OSI Reference Model</li> <li>• TCP/IP Model</li> <li>• Network Devices (with simulation)</li> <li>• Physical Layer</li> <li>• Carrier Media, Cabling, Copper and Optic Cabling</li> <li>• Data Link Layer</li> </ul>	<ul style="list-style-type: none"> <li>• Course Introduction</li> <li>• Exploring the Network</li> <li>• Configuring a Network Operating System (with simulation)</li> <li>• Network Protocols and Communications</li> <li>• Network Access</li> <li>• Ethernet</li> <li>• Network Layer</li> <li>• Transport Layer</li> <li>• IP Addressing</li> <li>• Subnetting IP Networks</li> </ul>

**Table 3.2** (continued)

- LLC, MAC, Layer 2 Access Technology, Network Switches, Ethernet, ATM Technology
- Configuration of Network Switches, VLAN, STP
- Network Layer Protocols
- IP, IP Addressing, Routing Types, Transport Layer
- Introduction to Routing and Packet Forwarding (with simulation)
- Introduction to Dynamic Routing Protocols (with simulation)
- Router Configuration, RIP, OSPF (With simulation)
- TCP, UDP, Application Layer
- WEB, FTP, Mail Services (with simulation)
- Application Layer
- It's a Network
- Introduction to Switched Networks
- Basic Switching Concepts and Configuration (with simulation)
- VLANs
- Routing Concepts
- Inter-VLAN Routing (with simulation)
- Static Routing (with simulation)
- Routing Dynamically (with simulation)
- Single-Area OSPF (with simulation)
- Access Control Lists
- DHCP
- Network Address Translation for IPv4 (with simulation)

Table 3.2 gives information about the content of the computer network courses.

### *Course 1*

The first course was offered as free extra-curricular course to all students of METU. The classes were made face to face in METU Continuing Educating Center. Since it is a simulation-based course, students use a simulation program to perform the laboratory activities. The duration of the course was 20 weeks. The course included four components, which were lecturing, simulation, online platform, and laboratory session. Online platform included course and laboratory manuals so that students could easily reach the course materials. In the first ten weeks of the course, students used a simulation program and an online course platform. Laboratory sessions with real devices were the second part lasting another 10 weeks.

In the first 10 week of the course, students used a simulation program. All of the students were provided with computer and laboratory manuals so that they could use the simulation program of the course.

The Objectives of the Course:

- Describe basic concepts of data traffic
- Describe the different classes of IP addresses (and subnetting).
- Install and/or configure a network.
- Describe data link and network addresses and identify key differences between them.
- Describe the function of the MAC address.
- Describe the different classes of IP addresses (and subnetting).
- Identify the functions of the TCP/IP network-layer protocol.
- Configure a computer in a network.
- Add the RIP routing protocol to your configuration.
- Install and/or configure a network.

## *Course 2*

The second course was the first semester of a Technology Certificate Program on computer networks. The purpose of the course was to present computer networking knowledge and skills. The duration of the course was 10 weeks and was followed by three more courses to be taken in sequence. Each of the courses concluded with part review quizzes so as to assess students' knowledge. Also at the end of the every course, there were part review exams to challenge students to recall information across multiple topics. The content of the course was similar to the first ten week of course-1.

Course-2 provides a peerless learning environment for teachers and students. It combines face-to-face and online course modes. In addition, it has simulation and laboratory session. In face-to-face part of the course, teacher presents the course to the students. With help of a learning management system, teachers and students could easily access course materials wherever and whenever they want.

The objective of the course:

- Describe data link and network addresses and identify key differences between them.
- Define and describe the function of the MAC address.
- Define and explain the five conversion steps of data encapsulation.
- Describe connection-oriented network service and connectionless network service, and identify their key differences.
- Describe the different classes of IP addresses (and subnetting).
- Identify the functions of the TCP/IP and OSI network-layer protocols.
- Configure IP addresses.
- Verify IP addresses.
- Add the RIP routing protocol to your configuration.
  
- Install and/or configure a network.

### **3.4 The Computer Network Simulation**

Computer network simulation program is a powerful tool that enables students to experiment with network behavior. It provides simulation, visualization, authoring, assessment and collaboration capabilities and it simplifies teaching and learning of complex computer network concepts. Network simulation program inserts physical network equipment in the classroom environment by allowing students to generate networks with unlimited number of devices. Also it encourages students to practice, discovery, and troubleshooting and enable students to can see content of data from each layer. Computer Network Simulation Platform is scalable graphic network simulation platform. It demonstrates real networks by simulating routers and switches. It can simulate large-sized networks and it allows users to exercise router and switch operations and to learn network technologies without using real devices.

Computer network simulation simulated the functions and features of routers and switches. By doing this, it enable students to study like they are in a real network environment. To study with a device in the Computer Network Simulation Platform, students only drag and drop the device in the work platform of the graphical user interface. In addition to routers and switches, platform simulates personal computers, clients-servers, cellphones, hubs, and clouds.

Computer Network Simulation simulates device configuration functions like hostname, ip address, subnet mask, gateway, and DNS. Students can easily give ip addresses, subnet masks, gateway and DNS addresses to a personal computer by using graphical user interface.

One of the most important properties of the Computer Network Simulation Program is that it simulates large-sized networking. Simulating large-scaled networks gives a chance to students to solve the problem in the simulation platform so that they can solve it successfully when they encounter a similar problem in real work environments.

Computer Network Simulation Program simulates packet capture on interfaces to show protocol interaction process by the help of Wireshark. With the Wireshark, students can see packets and layers of OSI and TCP/IP.

In this study, two simulation programs were used. Screen captures of simulation programs were given in the Appendix D. Both of the simulation programs have similar properties. Common attributions of programs are given below:

- **Workspaces:** Both of the simulation programs have two workspaces, which are logical and physical species. The logical workspace allows students to perform logical network topologies. In addition, physical workspaces provide to students a graphical physical dimension of logical network. It gives a chance for students to see how networks devices like router and switch would look in a real environment.
- **Networking Devices:** simulation programs support various networking devices like routers, switches, connections, end devices, hubs, and servers so that students can create different networking scenarios.
- **Connections:** various cable types which are console cable, copper straight-through cable, copper cross-over cable, and serial cables can be used in simulation programs to connect various networking devices. Auto cable connection is a useful property of simulation programs. While connecting various cables to network devices, it is important for students which type of cable they used. At this point, auto cable connection helps students to connect cables in a correct way.
- **Command Line Interface (CLI):** is a user friendly mode where students can type different commands so as to configure various network devices. CLI is a text based interface and it recognizes command when users enter enough character of the command.
- **Graphical User Interface (GUI):** with graphical user interface, users can create, delete, and save topologies. Also it enables users to easily drag and drop the network devices so that they create topologies. The GUI has zoom

view tools, edit functions like copy, paste, and undo, improved window management, and ability to show/hide interfaces and device labels.

- **Protocols:** simulation programs supports protocols working in application, transport, network and network access/interface layers.
- **Modular Devices:** physical interface enable insert interface cards to the routers like a real device.
- **Tutorials:** Simulation programs include many step-by-step tutorials so that students can be familiarized product features and engaged in simulations.
- **Help:** help feature is used to familiarize students to the simulation program. In addition, help feature includes many notes and tips to aid understanding.
- **Activity Wizard:** allows students to control their own learning activities by using instructional text.
- **Lab Grading Function:** provides students grading and feedback do that they can control their own learning activities.

### 3.5 Data Collection Instrument

During this study, interview is used as an instrument to collect data. As stated by Burns (1999, p. 118), “Interviews are a popular and widely used means of collecting qualitative data.” According to Flick (2006, p. 160), the purpose of interview is to express the knowledge in the form of answers and so it become open to interpretation. An interview was used so as to obtain the effects of the simulation program on the students’ attitude, motivation and learning. Using interview as an instrument in exploratory design has some strengths. These strengths are revealed by Jonson and Turner (2003, p. 308) as follows:

- Proper for measuring attitudes and other types of interest.
- Can provide detailed information.
- Proper for investigation and verification.
- Allow good interpretive validity

In this study, a semi-structured interview was used in the study. The purpose of the semi-structured interview was to determine the computer network students' thoughts about the effect of the simulation program's on attitude, motivation and learning.

According to Törnüklü (2000), in semi-structured interview, researcher prepares the interview questions in advance. Also researcher can affect the flow of the interview by asking sub-question so that participants can give detailed answers for the questions.

The most important facilities provided by the semi-structured interview technique for the researchers is that it presents more systematic and comparable information since the interview depend on question which are prepared in advance (Yıldırım and Şimşek, 2004, 283).

### **3.5.1 Attitude, Motivation and Learning Interview Protocols**

Interview is developed by the researcher. The interview consists of 11 open-ended questions and it consists of 3 subscales. These are attitude, motivation and learning. The first three questions are related with the attitude of the students toward the course. Question four, five, six, and seven is developed so as to measure the effect of simulation program on students' motivation. Lastly, the last four questions are developed to measure the effect of simulation program on students' learning. Researcher got feedback while he was preparing the interview questions. After the first draft of the interview questions was prepared, it was controlled by an associate professor who is expert on computer networks field at Computer Education and Instructional Technology Department. According to the feedback of the expert, revision on the interview questions were made by the researcher. After the revision, question was again controlled by the same expert. In addition to expert, a Ph.D. student in Computer Education and Instructional Technology Department checked the questions for validity and reliability concern. After 3 stage feedback, interview questions were reorganized and interview questions were finalized.

Motivation questions in the interview were prepared according to the ARCS Model. The model consists of four main categories which are Attention, Relevance, Confidence and Satisfaction. Categories of ARCS Model represent some conditions which are necessary for a person to be fully motivated (Keller & Suzuki, 2004).

### **3.5.2 Data Collection Procedure**

Interviewing data collection method was used in this study. In the study, the researcher chose the class of the participants as the interview environment so that they can feel comfortable and secure. 17 of 35 students were participated to interview as voluntarily and participants were decided when they participate to interview. The interview place was determined by the researcher. Participants were invited to the study with telephone and face to face meeting. Interviews were made one by one and they were recorded. During the interviews open-ended questions asked. Open-ended questions give chances to participants share their opinions instead of predetermined survey options. Usage of open-ended questions were not force the participants to say what researcher hear while they answering the questions. Before the interview, participants were informed about the purpose and duration of the interview. Also researcher got permission from the participants so as to record their voice during the interview. After the recording process, researcher transcript these records accurately. During the interview, questions were asked in a flexible way and answers of the participants were evaluated in an unbiased way.

### **3.6 Data Analysis**

Data analysis was made so as to lighten the meaning and bring order the data. Qualitative content analysis was preferred so that the data was discovered and described in a systematic way.

The data was described by analyzing the interview transcriptions. During the data analysis, the proper themes and categories from the transcriptions were found. After definition proper themes and categories, meaningful results were found.

### **3.7.1 Dependability**

The reliability is the most important feature of data and findings for a research to be credible. Reliability is related with the consistency, dependability, and replicability of the obtained research results (Nunan, 1999). In quantitative studies, obtaining the same results is easy because data are in numerical format. However, in qualitative studies, having identical results are demanding and difficult because data are in narrative format and it is subjective. According to Lincoln and Guba (1985), it is better to take into consideration dependability and consistency of the data instead of same results. Dependability of the results can be provided with three ways: the investigator's position, triangulation and audit trail (Lincoln & Guba, 1985; Merriam, 1998). According to Lincoln and Guba (1985) audit trial is one of the important elements that establish the credibility of qualitative studies. In this study the credibility of findings was established through a lot of audit trails. Those were data collection techniques, data analysis procedures, excerpts from transcribed data, and exploration and detailed description of themes and categories drawn from raw qualitative data.

### **3.7.2 Credibility**

In qualitative research studies, credibility depends on researcher's ability and effort; therefore, "the researcher is the instrument"; however, in quantitative research studies credibility depends on construction of the instrument (Patton, 2002, p. 14). Triangulation is a way of establishing and ensuring the credibility in qualitative research (Merriam, 2009). In this study credibility was ensured through triangulation of data. That is, analysis of data and generation of themes and categories were

conducted independently by two researchers. Once the researchers completed their themes and categories independently they come together and compare their results with each other. The final themes and categories were established after they had consensus on them. By this way credibility of the results of the study was addressed. Cohen's Kappa statistics was utilized to examine inter-coder reliability. Because, Cohen's Kappa is a commonly used index of inter-rater reliability that used to measure level of agreement of two researchers' codes (Cohen, 1960). The results of the inter-coder reliability on this study showed that kappa was equal to 0.72 which showed that there was a substantial agreement between two coders. According to Landis and Koch (1977), kappa values between 0.61 and 0.80 are substantial.

### **3.7.3 Transferability**

In qualitative paradigm, transferability or applicability is an essential criterion for the quality of research study (Lincoln & Guba, 1985). Generalization of findings from one study to another may not be proper for the qualitative studies. However, there are some other ways of transferring the results of one qualitative study to another such as rich and thick description of data. That is, the context and the sample should be explained in detail so as to enable other researcher to benefit from the research findings (Meyer, 2000, p. 9). In this study, detailed description of data was provided in order to establish transferability. For example, all of the interviews were transcribed and written in a Word document. Moreover, the quotations used by researcher were directly taken from transcribed data without any manipulation. This allowed other researchers to transfer and generalize the results of this study to the other context and settings. Furthermore, by this way researchers would be able to decide whether the results of this study are transferable to their own context.

### **3.7 Assumptions of the Study**

In this study some assumptions were made. These assumptions are:

- The interview environment are proper for the interview,
- In the study, two simulation programs were used and they were used like they are similar.

## CHAPTER 4

### RESULTS

In this chapter, the results of the data analysis were given. The results were given as parallel to research questions. Each research question was detailed with the participants' answers. The participants' code list is given in the Appendix C.

**Table 4.1** Alignment of Theoretical Framework of the Results of Study

<b>Model</b>	<b>Components of Model</b>	<b>Categories of Study</b>
<b>ABC Model</b>	Affective	Curiosity Interest
	Behavioral	Information Age Qualities Personal Development Problem Solving Skills
	<b>ARCS Model</b>	Attention Relevance Confidence Natural Consequences
<b>Discovery Learning</b>	Experimenting	Provide Concreteness
	Allowing Trials without Fear of Failing	Learning by Applying Visuality

Table 4.1 indicates the alignment of theoretical framework of the results of study.

The study was carried out according to the ABC Model of attitude, ARCS Model of Motivation and Discovery Learning. Codes were categorized based on the

components of the models. In this basic qualitative study, two components of attitude which are affective and behavioral matched the attitude findings of this study. Affective component of attitude deals with some *internal factors* like feeling and emotions. *Learner Internal Factors* theme constructed based on affective component of attitude. *Feeling, emotions* and attitude are combined so as to propose an integrated model of attitude (Agarwal & Malhotra 2005). Based on the affective component of attitude *curiosity* and *interest* categories were constructed. Also in this study participants mentioned that some *personal intentions* like *solving internet problems, career plans*, and keeping up with the *computer age*. *Goal Setting* theme was generated according to the behavioral component of attitude. Behavioral tendency of an individual consists of actions and observable responses that are the result of attitude object (Wicker, 1969). Participants said that they act in a specific way to perform *their intentions*. According to Ajzen and Fishbein (1975), *behavioral intention* was an individuals' subjective possibility to act in a certain behavior.

The motivation results of the study are proper of the Keller's ARCS Model. "*Self-confidence*" and "*locus of control*" were two themes constructed in this study. *Self-confidence* theme was mentioned confidence strategies of ARCS Model. *Self-confidence* is one of the sub-strategies of ARCS Model (Keller, 1987a). *Visuality* is one of the categories was found in this study. According to Keller (1987a, p. 4-5), concreteness subcategory of attention strategy proposes the use of *visual representations* of any object to motivate students towards the course. Also *manuals* provided by simulation programs *as an alternative method* to learn network concepts increased participants motivation. Choice subcategory of relevance strategy is related with the *providing meaningful alternatives* for accomplishing a goal (Keller, 1987a, p. 4-5). "*Locus of control*" controlling success and failure is another theme. Individuals should be more motivated when they feel that they can control their own success and failures (Eccles & Wigfield, 2002). *Trial and Error* and *Change to Practice* were two categories combined under the locus of control theme. Participants mentioned that *Trial and Error* provided by simulation program increased

participants' motivation towards the course since they have a *personal control* over the learning. *Personal control* strategies of Confidence category of ARCS Model are related with the providing personal control over the learning (Keller, 1987b). *Change to Practice* mentioned by participants in simulation platform is another category increase participants' motivation by providing them a *realistic platform* to practice the network laboratories. Natural consequences of Satisfaction strategies propose *allowing students to acquire new skills* in a realistic setting (Keller, 1987a, p. 4-5).

Lastly, theme and categories under the learning results of current study were developed parallel to the Discovery Learning approach. Schank and Cleary (1995) have proposed five main architectures which are case-based learning, incidental learning, learning by exploring/conversing, learning by reflection, and simulation-based learning for categorizing the architectures of discovery learning. Simulation-based learning was one of these categories. Simulation-based learning environments allow to learners for *experiments and trials without fear of failing, and concretization* (Bicknell - Holmes & Hoffman, 2000). The "*Provide Concreteness*" and "*Learning by Applying*" categories of the study were determined according to the features of discovery learning. There are five major differences between discovery learning and traditional learning (Bonwell, 1998; Mosca & Howard, 1997):

- Learning is active rather than passive
- Learning is process-based rather than fact-based
- Failure is important
- Feedback is necessary
- Understanding is deeper

As mentioned above, *Deeper Understanding* is provided by the Discovery Learning. The theme called as *Deep Understanding* was constructed based on the suggestion of discovery learning that is "*understanding is deeper*".

**4.1 Attitude:** How did using the computer network simulation program effect students' attitude towards the course content?

Students were asked about the factors affecting their attitude towards the computer network topics. The answers of the participants were collected under two themes, “goal setting” and “learner internal factors”. Tables 4.2 summarize the themes and categories related with attitude of students' towards course content.

**Table 4.2** Attitude themes and Categories

Themes	Categories
<b>Goal Setting</b>	Information Age Qualities
	Professional Development
	Problem Solving Skills
<b>Learner Internal Factors</b>	Curiosity
	Interest

Table 4.2 shows themes and categories related with the attitude of the students towards computer network course.

Goal setting is the first theme found in the attitudes of the interviewed students. Goal setting is related to the process of deciding what you want to accomplish and devising a plan to achieve the result you desire. Students stated that personal development in a field like computer networks is very important for them because of their career goal. As a typical answer related to this theme one of the student said:

*“I want to learn high level topic in this field because it is my purpose to work in this field.” (CIP2)*

*“Bilgisayar ağları ile ilgili üst düze konuları öğrenmek istiyorum. Çünkü amacım bu alanda çalışmak.” (CIP2)*

Some of the keywords related to this theme were computer age, career, and solving internet problems which were further grouped into categories (Detail were given in Table 4.9). Interviewees mentioned the revolution in technology in the form of internet and personal computers. Many of the new technologies require new knowledge and skills. For this reason, “*information age qualities*” was one of the categories driven from the answers of participants.

**Table 4.3** Attitude categories and frequencies for goal setting theme

<b>Theme 1: Goal setting</b>			
<b>Categories</b>	<b><i>f</i> for Course 1</b>	<b><i>f</i> for Course 2</b>	<b>Total <i>f</i></b>
Information Age Qualities	3	2	5
Professional Development	5	7	12
Problem Solving Skills	4	1	5

Table 4.3 shows the frequencies of goal setting categories.

“*Information age qualities*” was the first category related to the goal setting theme of students’ attitude toward course content questions. Some of the participants mentioned that they took this course because we are living in computer age. They thought that IT technologies are widespread and almost all of the professions have a connection to it. Table 4.3 shows categories and frequencies for goal setting theme. Some of the typical quotations from the interviews in these categories are provided below:

“*Since we live in this system, we should have information about computer networks. There is a growing system. We must learn computer networks not to be a small fish in the computer age.*” (CIP1)

*“Çünkü zaten bu sistemin içinde yaşıyoruz. Gittikçe büyüyen bir sistem var. Küçük balık olmamak için bilgisayar ağlarını öğrenmeliyiz.” (C1P1)*

*“The basic level computer network knowledge is needed because we live in technology age. But every people would not know high level knowledge at this field.” (C2P5)*

*“Basic düzeyde bilgisayar ağları bilgisine herkesin ihtiyacı var çünkü hani dönem teknoloji dönemi olduğu için ama üst seviyeye geçmesine gerek görmüyorum yani.” (C2P5)*

Interviewees also talked about developing their existing knowledge and skill and the importance of professional development. Most of the participants in this study had a profession with computer networks or planned to work in the IT field. Because of their future plans were related to computer networks, they said that they had a positive attitude towards computer networks. By taking into consideration the answer of participants, second category was found to be *“professional development”*. Considering that development of skill is largely relied on its practice, the simulations in network course allowed students to facilitate development of profession-related skills and improvement of knowledge related to network topics. This was clearly indicated by following participant.

*“I focused computer because of my job. So I want to take high level computer network courses.” (C2P5)*

*“Yani şu anda işimden ötürü hani işimden ötürü biraz daha bilgisayar üzerine yoğunlaştığım için daha çok bilgisayar üzerine yoğunlaşmaya karar verim gibi bir şey yani. O yüzden üst seviyede bilgisayar ağları konularını öğrenmek isterim.” (C2P5)*

*“I am an industrial engineering student and I know we will be expert on IT. Technology and IT will reach a higher level in coming years and it will be very important for the companies. So I want to expert in computer networks.” (C1P3)*

*“Zaten Endüstri Mühendisliğinde öğrenciyim. Bilişim üzerine uzmanlaşacağımızı biliyorum ve ilerleyen dönemlerde gelecek yıllarda da teknolojinin bilişimin daha üst seviyeye ulaşacağını ve şirketlerde daha önemli yer alacağını düşünüyorum ve ondan dolayı da bilgisayar ağları alanında ilerlemeyi isterim.” (C1P3)*

Many of the participants in this study mentioned that they take this course because of their profession and most of the participants plan to have a career in the computer networking field. For some of them, even though their assumed profession is not directly about computer network, it is indirectly related to computer networking. Some of the related answers of participants’ are provided below:

*“I want to take high level courses at this field. The most important reason is that it is related to my profession. Currently, I am a research assistant but I think to study at this field in the future. Computer network is a good and developing field. So I want to increase my knowledge.”(C2P2)*

*“Yani e tabi önemli en önemli sebebi mesleğimle ilgili. Şu anda araştırma görevlisiyim ama ilerde bu alana geçebilme ihtimalimin olduğunu düşünüyorum. İstiyorum da çünkü güzel bir alan olduğunu ve geliştirmekte olan bir alan olduğunu biliyorum. Bu yüzden bu alanda bilgimi arttırmak istiyorum.” (C2P2)*

Lastly, participants talked about internet problems they encounter in their daily life and how it affects their performance. People use internet in their daily life for many reasons such as connecting with other people, sharing files, getting information and so on, it is integral to their lives. Because of this reason, participants thought that people have basic networking skills so as to solve daily life internet connection problems. According to answers of participants’ third category under the Goal setting theme was found to be *“problem solving skills”*. Some of the participants mentioned that they took this course because they use internet and they think they could improve their knowledge and skills so as to solve daily internet problems. They thought that almost all people around them have a computer and internet connection. So they want to learn computer networks so as to solve simple internet connection problems in

their daily life. Participants' answers related with "Problem solving skills" category was given below:

*"Everyone should have some knowledge about computer networks since all people are a computer user. When we have a simple problem related with connection, we should be able to handle it." (C1P8)*

*"Her insan az çok bilgi sahibi olmalı hani detaya girmesek bile çünkü sonuçta hepimiz bir bilgisayar kullanıyoruz network alanında. Ufak bir sorunda kendimiz halletmemiz daha mantıklı." (C1P8)*

*"Today, all people have a computer. Also they have a modem to internet connection. So people use modem, which is a basic computer network device. So as to configure modem, people should have network knowledge. For this reason, everyone should know the basic, entry-level computer networks. (C2P2)*

*"E günümüzde herkesin evinde bilgisayar olduğuna göre, e uzaktan da olsa modemle bir ilişkileri var aşında. E hani en temel yapı birimi olarak bilgisayar ağları bilimi olarak modem kullanıyorlardır. Onu bile konfigüre etmek için bazı şeyler bilmek gerekiyor. Hani herkesin temel girişi seviyesinde bilgisayar ağları bilmesi gerektiğini düşünüyorum." (C2P2)*

"Learner Internal Factors" was the second theme which was related to students' attitudes towards the course. It is related with reactions that people create inside themselves. Curiosity, attention and interest are some of these reactions. The reasons that make those factors to be emerged were that students' interest in the course was driven by their curiosity about the content of the network course.

*"The course took my attention. I enjoy it. So I want to high level courses at this field." (C2P1)*

*"Ağlar çok ilgimi çekti çünkü zevk alıyorum. O yüzden bu alanda ileriye de gitmek isterim." (C2P1)*

This theme had two categories named as “*curiosity about the content*” and “*interest*”. The first category “*curiosity about the content*” was generated according answer like “how developed”, “different thing”, and so on based on words indicating their curiosity to the computer network course. The last category defined was “*interest*” according to answers of participants. They used the term *interest* directly in their answers. So, researcher used this category as a part of learner internal factor.

**Table 4.4** Attitude categories and frequencies for learner internal factors theme

<b>Theme 2: Learner Internal Factors</b>			
<b>Categories</b>	<b><i>f</i> for course 1</b>	<b><i>f</i> for course 2</b>	<b>Total <i>f</i></b>
Curiosity about the Content	5	4	9
Interest	7	4	11

Table 4.4 shows categories and frequencies for Learner internal factors theme.

“*Curiosity about the content*” is another category affect students’ attitude towards computer network course. Some of the participants mentioned that they take this course because they want to know how computer networks work. A participant’s answer was given below:

*“I take this course because I want to learn how computer networks work and how this technology develops. When I started to be interested computer, I saw that there are many different things in computer networks. For this reason, I should learn computer networks.” (C1P3)*

*“Zaten benim bu derse başlama sebebinden birisi bu ağların nasıl yapıldığını, bu teknolojinin nasıl geliştirildiğini öğrenmek istemiştım çünkü yani bilgisayarın içine girdiğimiz zaman network alanında çok daha farklı şeyler olduğunu da gördüm. Bence çoğu kişi öğrenmeli.” (C1P3)*

The last category related with attitude is “*interest*”. Interest of participants to the computer network is another point why they took this course. Most of the participants mentioned that they are interested to the computer network topics. For this reason they take this course. Answers of participants are provided below:

*“I think that people who are interested to the computer networks should take this course. It can be difficult but if you have no interest.” (C1P4)*

*“Çünkü hani biraz ilgi alanına bağlı bir alan çünkü ilgi alanınız yoksa bu alanda sizi zorlayabilir yani biraz ilgi alanınız varsa bile almanız çok faydalı.” (C1P4)*

*“I noticed that computer networks interests me as I continued to the lecture. For this reason, I will continue to learn high level topics related with computer networks.” (C1P7)*

*“İlgimi çeken bir konu olduğunu fark ettim daha sonra derslere girdikçe. O yüzden bu alandaki üst düzey konuları öğrenmek isterim” (C1P7)*

**4.2 Motivation:** How did using the computer network simulation program effect students’ motivation in the computer network course?

Students were asked about how the simulation program affected their motivation in the computer network course. The answers of the participants were categorized under two themes, “self-confidence” and “locus of control”. Table 4.5 shows themes and categories for motivation. The first theme is “*self-confidence*”. Related to self-confidence theme the participants mentioned that simulation program provided them the feeling of “I can do it” since it includes visuals of all network devices, and manuals showing them how they could perform the tasks.

The second theme was “*locus of control*” which is related to individuals’ control over attributes around them such as success, failure. That is, it is defined as the perceptions of students on the results of their behaviors. A person who has locus of control will

never say something like "I failed because the task was hard" but instead he or she takes responsibility by asking himself questions such as "what was the wrong thing I did" and "how can I prevent that from happening the next time".

*“In simulation platform, I made a lot of mistakes. I tried many times a laboratory application. After these mistakes, I found the correct way and I learned how devices work in the simulation platform.” (C1P3)*

*“Bir tane simülasyonu dokuz on kere bile denediğim oldu bazı kendi hatalarımdan dolayı, küçük hatalardan dolayı. Simülasyonu yapma amacımı öğrendikten sonra da yanlışlar yaparak onları düzelterek simülasyonu düzgün bir şekilde bitirdim.” (C1P3)*

**Table 4.5** Motivation themes and Categories

Themes	Categories
Self-confidence	Visuality
	Manuals
Locus of Control	Chance to Practice
	Trial and Errors

The first theme consists of two categories that are “visuality” and “manuals”. “Visuality” is the first category mentioned by participants. Visuals of network devices in the simulation program enable students to motive to the course. Most of the participants in this study mentioned that simulation program provide them visuals. The answers of participants were given below:

*“Simulation program helped me for better understanding of computer network course. The concept of computer networks was complicated for me and I cannot imagine this concept. However, with the simulation program, imagining this is very easy for me.” (C2P7)*

*“Yani daha iyi kavramayı sağlıyor. Yani gözümde bilgisayar ağı deyince insanın gözünde kavramlar canlanmıyor. Simülasyon olduğu zaman daha güzel gözünde canlanıyor.” (C2P7)*

*“Of course, I want to take a course with simulation since it is very beneficial. It is easy to learn since it includes visuals.” (C1P4)*

*“Tabi tabi çünkü çok faydalı oluyor. Görsellik açısından çok önemli. Network cihazlarını görebiliyorsunuz. Bu sebeple simülasyon ile işlenen bir ders daha almak isterim.” (C1P4)*

Other category was “manuals” provided by simulation programs. Most of the participants mentioned that simulation program was very useful since it provided manuals so that they perform a laboratory activity without the need for help of anyone. They did not encounter any big problem during the usage of simulation because of those manuals. Details were given in table 4.6. Some of the participants’ answers were given below:

*“During the lab session, we have manuals about simulation. I did not have any problems because of manuals, while I was using simulation program.” (C1P2)*

*“Labta elimizde işte şeyler vardı. Konuyu anlamamıza yarayan instructionlar vardı. Onları takip ederek kullandık. Bi sıkıntı çıkmadı.” (C1P2)*

*“I used manuals so as to apply what we learned during the lesson in simulation program” (C2P3)*

*“Derste gördüğüm konuları simülasyon ortamında denedim. Simülasyonun örnek ders manuellere kullanmak, işimi daha da kolaylaştırdı. Bu işi yapabileceğimi anladım.” (C2P3)*

**Table 4.6** Motivation categories and frequencies for self-confidence theme

<b>Theme 3: Self-confidence</b>			
<b>Categories</b>	<b><i>f</i> for course 1</b>	<b><i>f</i> for course 2</b>	<b>Total <i>f</i></b>
Visuality	4	3	7
Manuals	5	5	10

Table 4.6 shows frequencies of the categories under self-confidence theme.

The second theme found was locus of control. This theme includes two categories which are “*chance to practice*” and “*trial and errors*”. Participants thought that simulation programs help them to make practice and try an activity many times until they find the correct path. They took control over their own failure and success. For this reason two categories gathered under one theme “locus of control”

**Table 4.7** Motivation categories and frequencies for locus of control theme

<b>Theme 4: Locus of Control</b>			
<b>Categories</b>	<b><i>f</i> for course 1</b>	<b><i>f</i> for course 2</b>	<b>Total <i>f</i></b>
Chance to Practice	6	5	11
Trial and Errors	4	3	7

Table 4.7 shows frequencies of the categories under locus of control theme.

“*Chance to practice*” is another category affecting students’ motivation towards the course. Most of the participants mentioned that simulation program provide them a chance to practice on the procedural knowledge. They thought that after face to face instruction, making practice with the related topic was very beneficial.

*“I want to take another course with simulation because simulation program give me a chance to practice.” (C1P2)*

*“Simülasyon ile bir nevi uygulama yapmış oluyorsun. Bunun çok faydası var. Bu yüzden simülasyon ile işlenen başka derslere de katılmak isterim.” (C1P2)*

*“It is not enough to learn the computer networks topics when teacher give the course by only speaking. At this point, simulation program is very beneficial to practice. (C1P5)*

*“Sadece derste hoca bir şeyler anlattığı zaman eğitim yeterli olmuyor. Özellikle simülasyon yapılması çok etkili oluyor. Labların çok büyük katkısı olmuştu hatta bence sayısının da arttırılması lazım.(C1P5)*

The last category related to motivation was “*trial and error*”. Most of the participants mentioned that simulation program provide them a trial and error learning. With this property of the simulation program, they could try a laboratory activity many times until they could accomplish the task. They stated that this was motivating. Some of the participants’ answers are given below:

*“In simulation platform, I made a lot of mistakes. I tried many times a laboratory application. After this mistake, I find the correct way and I learned how devices work in the simulation platform.” (C1P3)*

*“Bir tane simülasyonu dokuz on kere bile denediğim oldu bazı kendi hatalarımdan dolayı, küçük hatalardan dolayı. Simülasyonu yapma amacımı öğrendikten sonra da yanlışlar yaparak onları düzelterek simülasyonu düzgün bir şekilde bitirdim.” (C1P3)*

*“We configure network devices in the simulation platform. We have a chance in the simulation program so as to check whether configuration is correct or not. So we tried many times in simulation program until we learn. (C1P9)*

“Simülasyon programının sağladığı föylerden kodları girerek doğru olup yanlış olup olmadığını kontrol etme şansımız oldu. Bildiklerimizi simülasyon programı üzerinden deneme yanılma ile öğrendik.” (C1P9)

**4.3 Learning:** What were students’ perceptions about the effect of using computer network simulation program to learning the course content?

Students were asked about how the simulation program affects your learning the computer network course. The answers of the participants were categorized under one theme named as “*deep understanding*” which includes three categories. Table 4.8 shows the theme and categories related with the students’ perceptions about the effect of using computer network simulation program to their learning the course content.

**Table 4.8** Student learning theme and categories

Theme	Categories
Deep Understanding	Provide Concreteness
	Learning by Applying
	Visuality

Categories were constructed according to the keywords that participants used in their answers during the interview. Details were given in Table 4.9. The first category is “*provide concreteness*” was found by taking into consideration the keywords like abstract and invisible. Second category is “*learning by applying*” was found after all of the answers of participants was carefully examined. Practice and writing code keywords were taken into consideration while researcher were deciding “*learning by applying*” theme. The last theme that came out from the interview data was “*visuality*”. This category was chosen according to visuals and images keywords. After categories were defined, these three categories were collected under one theme named deep understanding.

“Provide concreteness” is the first category found by researcher. Many of the students find the simulation program is very proper for the learning. There are many abstract topics in the computer network course. Students have problems while they try to understand the lesson. They thought that because of simulation program, they learn abstract topics easily. Some of the answers of the participants are given below:

*“Simulation program help me to understand concrete topics. Theoretical knowledge became concrete. If I did not use simulation, I cannot understand the abstract topics.” (C1P1)*

*“Mesela somut, somutlaştırdı. Teorik bilgi gittikçe somutlaştı. Yani simülasyonu kullanmasaydım soyut olarak kalacaktı. Teorikti. (C1P1)*

*“They are all abstracts concepts. We cannot see them. In routing, forwarding a packet from one place to another place is a good example for this. With simulation program, we can see the way of a packet. These are very helpful and we can see where we made mistake.” (C2P6)*

*“E sonuçta bunlar hepsi soyut kavramlar. Gözle göremediğimiz şeyler. Bir paketin bir yerden bir yere forwardlanması gibi routingte mesela. Sana simülasyonda özellikle packet tracer in simülasyon bölümünü açtığın zaman bu paketin nerden nereye hangi fazlardan geçtiğini hangi evrelerden geçtiğini görebiliyorsun.” (C2P6)*

“Learning by applying” is another category in this study. According to the answers of the participants, they thought that computer network course is an application-based course. For this reason, they need to apply what they learned in the course. Some of the participants said that simulation program help us to learn by applying. Table 4.8 shows categories and frequencies for deep understanding theme.

*“We learned some of the protocols theoretically. However, I wonder what about these protocols, why we use it. In simulation program, I applied these protocols in the routers and switches and I see protocols more closely.” (C1P1)*

*“Mesela en basitinden iki bilgisayar arasında iletişim kurarken çeşitli şeyler vardır mesela protokoller vardır. Bu protokoller nerden geliyor. Zembillen mi inmiştir şeklinde. Bunun tabi routerdan tanımlayarak şu şu bacaklar şu şu bacağa gitsin, şu bacak şunu yapsın falan şeklinde. Ki bunu simülasyon programı ile daha yakından uygulayarak görmüş oldum.” (C1P1)*

*“We cannot learn only by listening. I think that listening to teacher is important but writing codes in simulation program is more important.”(C2P2)*

*“Evet yani öğrenmek sadece dinlemekle olmuyor. Derste hocamızı dinleme tabi faydalı ama kodları bire bir yazarak uygulamak hani o yazılışları da öğrenmek en önemli kısmı. Çünkü tek başımıza kaldığımızda yapacağımız şey o. (C2P2)*

**Table 4.9** Learning categories and frequencies for deep understanding theme

<b>Theme 5: Deep Understanding</b>			
<b>Categories</b>	<b>f for course 1</b>	<b>f for course 2</b>	<b>Total f</b>
Provide Concreteness	6	5	11
Learning by Applying	8	4	12
Visuality	4	3	7

Table 4.9 gives categories related with learning and frequencies of these categories.

The last category in this part is the “*visuality*”. Some of the participants thought that simulation program provide visuals. With the help of visuals, they learn computer network course better. For this reason it is easy to learn topic with simulation program. Some of the answers of the participants are given below:

*“Simulation program helped me to learn topics easily. I think that visual memory is very important during learning and simulation provides this. So with simulation, network topics take place long time in your mind. I think it is useful.”(C1P4)*

“Çünkü hani görsel hafıza çok önemli olduğunu düşünüyorum hani görselliğin çok önemli olduğunu düşünüyorum. O yüzden daha akılda kalıcı oluyor. Eğlendiğim için daha çok akılda kalıyor. Daha faydalı olduğunu düşünüyorum.” (C1P4)

“There are many visual examples in the simulation program. These visuals helped me to understand the lesson better.” (C2P2)

“Tabi. Şimdi simülasyon kullanırken daha görsel oluyor. Küçük animasyonlar, videolar, resimler olabiliyor. Bu görseller konuyu anlamamı kolaylaştırdı.” (C2P2)

**Table 4.10** Keywords for Each Theme

Keywords	Themes	Categories
computer age, career, solving internet problems, companies, expert, handle, growing system	Goal Setting	Information Age Qualities Professional Development Problem Solving Skills
curiosity, interest	Learner Internal Factors	Curiosity Interest
accomplish, I can do it, practice, easy, imagine	Self-confidence	Visuality Manuals
my failure, trying many times, finding correct way	Locus of Control	Chance to Practice Trial and Errors
detailed, understanding, memorable, practice, writing code, concrete topics, easily, understand, applied, closely, visual memory, take place long time in your mind	Deep Understanding	Provide Concreteness Learning by Applying Visuality

Table 4.10 shows the keywords that were used to construct themes and categories in this study.

## CHAPTER 5

### DISCUSSION AND CONCLUSION

In this chapter, according to the results presented in the previous chapter, discussion and conclusion of the results are presented. Lastly, recommendations for the future study are presented.

#### 5.1 Major Findings and Discussion

In this part, the conclusion and discussion are presented according to the 3 research questions.

##### 5.1.1 Research Question 1: How did using the computer network simulation program effect students' attitude towards the course content?

The results of this study show that students' opinions about their attitude towards computer network is related to the profession they would like have for themselves in future, their interest to computer networks, our era where computer is a part of life, solving daily internet problems, and curiosity. Curiosity encourages students to participate the school activities that increase positive attitude towards learning.

Goal setting is a factor affecting students' attitude toward the course. Goal setting can be explained with the goal setting theory. Goal setting theory tries to explain individuals' effort for reaching their targets (Erez & Kanfer, 1983). Goal setting provide a positive contribution to the development of positive attitude (Bennett as cited in Demir, 2002; Demir, 2002).

In the study of Demir (2002), there are two group which are control and experimental. Participants of the experimental group set goals on their goal cards

every week. The results of the study showed that goal setting had slight contribution towards positive attitude development.

Since many of the participants of the research are undergraduate students, it is obvious that they plan their future; they strive for finding a profession that they would like to specialize in and have a career. It seems that they would like to spend their career time in a profession where they value and feel valued. This is to say that they believe that they will have better chances of finding a satisfactory job on other fields if they have skills on computer networks. Profession is one of the most important phenomenon shaping individuals' life (Bozdoğan, Aydın, & Yıldırım, 2007). Success in a profession is related with the attitude developed towards a certain profession (Çakır, 2005; Durmuşoğlu, Yanık, & Akkoyunlu, 2009). Therefore, we can conclude that their desire to find satisfactory professions positively influence participants' attitudes towards computer network course.

Another aspect of having basic computer knowledge and practice in our era is the ability to solve daily internet problems since, just like computers, internet dominates our daily and professional life. Participants have the view that by knowing computer networking more deeply, they can be able to solve the problems if they face any such as configuring a router to connect to the net, which, as pointed out by participants, is vital for our life. Goals of someone like solving internet connection problem in daily life increase positive attitude. According to Dembo (2000), development of positive attitude is an outcome of goal setting. Thus, it is reasonable for us to conclude that the desire to have the ability to be able to solve internet problems is a factor affecting participants' attitude towards computer network course.

Another factor influencing participants' attitudes towards computer network course is their interest of learning computer networking. Internal factors like curiosity and interest affect students' attitude towards the course. Curiosity affects attitude positively that results in lifelong learning, and achievement (Shernoff & Hoogstra, 2001; Thomas & Oldfather, 1997). One of the factors causing positive attitude is

technology age (innovations). Varies in innovation and someone's interpretation of it contribute an individual's attitude (Weick, 1990).

In addition, interest of people has an effect on the attitude. A key point for the positive attitude towards learning is catching interest of students and holding it (Dewey, 1913; Mitchell, 1993). Hence, this study reveals that students' interest is a factor on their attitude towards computer networking course. This finding may be a result of the fact that computer software is more effective than other methods so as to increase students' interest to the topic during the lesson (Geban, Askar, Ozkan, 1992; Hounshell, Hill, 1989).

According to the answers of the participants, there are many factors affecting the attitude of them towards computer network course. However, participants did not say anything about effect of computer network simulation program. In their study Haun et al (2005) found that the simulation program did not significantly have an effect of student attitudes towards science and science career, a finding consistent with other reports.

**Table 5.1** Components of Attitude

<b>Components</b>	<b>Explanations</b>	<b>Attitude Categories of Research</b>
<b>Affective</b>	Emotional or feeling segment of an attitude.	Curiosity Interest
<b>Behavioral</b>	An intention to behave in a certain way.	Information Age Qualities Professional Development Problem Solving Skills
<b>Cognitive</b>	Opinion or belief segment of an attitude.	

Table 5.1 shows relationships between the attitude components and categories related with attitude found in this study. In this basic qualitative study, two components of attitude which are affective and behavioral matched the attitude findings of this study. Results of study showed that many of participants took computer networks course because of their feelings like interest and curiosity. Affective component of attitude deals with feeling and emotions. Feeling, emotions and attitude are combined so as to propose an integrated model of attitude (Agarwal & Malhotra 2005). Also in this study participants mentioned that some personal goals like solving daily life internet problems, developing themselves in terms of their career plans, and keeping up with the computer age caused them to take computer network course. Behavioral tendency of an individual consists of actions and observable responses that are the result of attitude object (Wicker, 1969). Participants said that they act in a specific way to perform their intentions. According to Ajzen and Fishbein (1975), behavioral intention was an individuals' subjective possibility to act in a certain behavior.

#### 5.1.2 Research Question 2: How did using the computer network simulation program effect students' motivation in the computer network course?

A dictionary definition of motivation is "to provide with, or affect as, a motive or motives; incite or impel" (Webster's unabridged dictionary, 2001, p. 1254). Researchers in the field of education has long been recognized the importance of motivation on learning. Therefore, motivation as a phenomenon has been studied by different researchers under different contexts. To sum them up, consider this phrase from Lai (2001) literature review on motivation:

Motivation refers to "the reasons underlying behavior" (Guay et al., 2010, p. 712). Paraphrasing Gredler, Broussard and Garrison (2004) broadly define motivation as "the attribute that moves us to do or not to do something" (p. 106). Intrinsic motivation is motivation that is animated by personal enjoyment, interest, or pleasure. As Deci et al.

(1999) observe, “intrinsic motivation energizes and sustains activities through the spontaneous satisfactions inherent in effective volitional action. It is manifest in behaviors such as play, exploration, and challenge seeking that people often do for external rewards” (p. 658). Researchers often contrast intrinsic motivation with extrinsic motivation, which is motivation governed by reinforcement contingencies. Traditionally, educators consider intrinsic motivation to be more desirable and to result in better learning outcomes than extrinsic motivation (Deci et al., 1999).

In addition to definition of motivation, some of the motivational aspects of learning are

- Peer collaboration
- Learning by doing
- Fun
- Problem based inquiry
- Goal oriented activities
- Real life experiences.

The results of the study are in harmony with literature on the importance of motivation on learning since participants think that simulation program increase their motivation for the computer network course and this, as a result, increase their learning. Participants thought that simulation positively affects their motivation in computer network course because

- Simulation program provide visuals,
- There are many manuals to guide students,
- It provides the chance to practice,
- Simulation program gives the chance for trial and errors.

Participants of this study declare that simulation program increases their motivation because it provides visuals, which foster their learning. There is vast body of research indicating that words are abstract; visuals, on the other hand, help learners to retrieve and remember information better. Visualization increase learning performance and it enables students to get a higher cognitive level (Ainsworth, 2006). Therefore, there has been a tendency to prefer visuals to texts; or, including visuals in the instruction with other media. As a result of this study, we see that participants think that the simulation program has a positive effect on the computer network course since it provides visuals to them. It is their belief that they can see the networking processes with their eyes via simulation instead of reading some texts of a book or a journal. They hold the view that visually witnessing networking processes is a lot better in terms of learning than mere reading. Therefore, we can conclude that participants of this study think that simulation program increase their motivation on computer network course. This finding is line with other studies in literature. For instance, Yair (2000, p.205) says that current perspectives suggest that activities that are challenging, novel, diverse and authentic may help students to involve in learning. However, instruction with lack of authenticity, allowing few degrees of freedom, and demanding few skills will produce low motivation, a sense of failure, and low mood for learning.

Building a real-life networking laboratory may require space, time and sources. Simulations, however, eliminate all of these downsides. Moreover, working algorithms of network systems cannot be observed even in a real-life laboratory. For example, a real-life laboratory cannot provide information on how some specific protocols operate since these protocols are abstract. Participants of this study, nonetheless, are aware of the fact that simulations can overcome this problem. By coming up with simulations of network protocols in the sense cartoons or video clips, simulations can provide a unique experience to computer network course students. Hence, another result of this study is that participants consider simulation program having positive effect on their motivation on computer network course. In a similar

manner, according to Funke (1988), simulations increase higher levels of arousal, motivation, task engagement, and quality of problem solving in students than traditional classroom methods so simulations are thought to be effective.

One of the problems that may theoretically be experienced by students who use simulations is their lack of experience with simulations and lack of sources to show them how to use it. However, this was not the case in this study. Participants say that there are many guides of simulation program and they find these guides helpful. If there was no guides and hence no help for participants on how to use simulation program, it would have decreased their motivation towards the course. Thus, participants of this study declare that simulation program, with its many useful guides, increase their motivation on computer network course. In their study, Sahin and Yildirim (1999) had similar findings where they reported that learning environment with computers make instructional process powerful and increase students' motivation. Also, advanced interactive computer programs are increased students motivation (Ustun and Ubuz, 2004).

Participants consider the ability of simulations to provide practices to them to be the one of the most important aspects of simulations since these practices open the way to them to master network skills. Learning by doing is an important concept in educational research nowadays, which includes the view of getting students actively do what they need to learn instead of abstractly reading or studying it. Participants, thus, claim that simulation program have a positive effect on their motivation on computer network course. Similarly, Doulai (2001) stated that computer simulation programs improve the motivation of the learner by enabling exploration activities, which increase their learning performance. Moreover, according to the study results of Josephsen and Kristensen (2006), students like working with simulation programs and they find it motivating.

There are two types of factors affecting motivation that is internal and external. Self-confidence which is internal factor of the students has an important effect on the

motivation. Self-confidence refers to belief of someone to accomplish goals and perform tasks completely (Dörnyei, 2001). Self-confidence affects a person's motivation to learn and use L2 (Clément, Gardner and Smythe, 1977). In addition, According to Dörnyei (1994b), self-confidence is a major motivational sub-system for the foreign language learning environments.

Technology enables students to learn with different ways including text, digital presentations, discussion boards, images, charts & graphs. Choices like these provide students a sense of ownership over their learning which has been shown to increase both motivation and learning (Ames & Ames, 1990; Davis, 1993; Knowles, 1986; Newcomb & Warmbrod, 1974).

Locus of control is another theme founded in this study which affects students' motivation towards course. Individuals should be more motivated when they feel that they can control their own success and failures (Eccles & Wigfield, 2002). Many of the participants thought that they can practice with simulation program and they learn by trial and error method. This causes that they control their success and failures.

With the help of simulation, participants learn topics by practicing and trial and error. By doing this, participants attribute to success to themselves. When students succeed something without help of the teacher, they develop greater confidence and become more motivated to succeed (Cashin, 1979; Lucas, 1990; Weiner, 1974, 1986).

An important upside of simulations, according to the participants of this study, is that simulations bestow them the opportunity to try and learn with whichever scenario they desire. This would be really hard in real-life situations because of cost and other realities. An institution of learning cannot provide real machines or devices to students to explore because of the possibility of spoilage. As participants of this study make clear simulations can remove this problem with their spoilage-free nature. Participants say that they can have many trials and errors with simulations, which, in turn, can increase their learning. Hence, this study reveals that participants believe that simulations increase their motivation on computer network course. According to

Shneiderman (1993), creation, exploration and discovery are the key factors for the student motivation. Sylwester (1995) claimed that engagement is critical for motivation of the students. Since participants in this study think that simulation provides them the opportunity of trial and error, they may be more engaged to network class and as a result have more motivation on it. To add, simulation program have advantages in terms of time, security cost, and motivation in addition its nature to protect students from dangerous, difficult, and impossible experiments (Rodrigues, 1997; Tekdal, 2002).

Results of the study shows that students' answer related with the motivation questions are proper for the ARCS Model. The table 5.2 shows the four main category and their sub-categories with the results of the study.

**Table 5.2** Motivation Results in terms of ARCS Model

<b>ARCS Model</b>	<b>Sub Categories</b>	<b>Motivation Categories of Research</b>
Attention	Concreteness	Simulation program provide visuality.
Relevance	Choice	Manuals for laboratory
Confidence	Personal Control	Trial and error chance
Satisfaction	Natural Consequences	Chance to practice

Table 5.2 shows relationships between the ARCS Model sub categories and categories related with motivation found in this study.

The motivation results of the study are proper of the Keller's ARCS Model. In the study students mentioned that simulation program provide them visuality and this properties of it enable students' to motivate to the course. According to Keller (1987a, p. 4-5), concreteness subcategory of attention strategy proposes the use of visual representations of any object to motivate students towards the course. Also

participants in the study mentioned that manuals provided by simulation programs as an alternative method to learn network concepts increased their motivation. Choice subcategory of relevance strategy is related with the providing meaningful alternatives for accomplishing a goal (Keller, 1987a, p. 4-5). In this study participants mentioned that trial and error provided by simulation program increased participants' motivation towards the course since they have a personal control over the learning. Personal control strategies of Confidence category of ARCS Model are related with the providing personal control over the learning (Keller, 1987b). Change to practice mentioned by participants in simulation platform is another factor increase participants' motivation. Participants thought that simulation platform provide them a realistic platform to practice the network laboratories. Natural consequences of Satisfaction strategies propose allowing students to acquire new skills in a realistic setting (Keller, 1987a, p. 4-5).

### 5.1.3 Research question 3: What were students' perceptions about the effect of using computer network simulation program to learning the course content?

The result of the study reveals that simulation program helps participants to learn computer network topics. In this sense, participants claim that simulation program has a positive effect on their learning of computer network course. Participants provide three reasons for this:

- Simulation helps them to learn abstract topics better than conventional ways,
- Simulation gives them a chance to learn by applying,
- Simulation provides them visuals.

One of the biggest challenges pointed by participants of this study on learning computer network courses is that computer network course include many abstract concepts and procedures that they find it hard to grasp and relate them. However, simulation program gives them a chance to study these abstract concepts and

procedures in a visual and concrete way so that it becomes easier for them to apprehend. Simulation program's nature to have an interactive way of studying network subject can be considered as an important feature over the other conventional ways of teaching network subject. This conclusion is line with other studies conducted in the field. For example, Demirci (2003) states that usage of animation and simulations for the learning of abstract topic in interactive learning environment help students become active in their learning and provide opportunities for the students so as to construct and understand difficult concepts easily.

Many of the participants in the study think that simulation helps them to practice. With the simulation program, they learn by applying what they see theoretically in the lesson. According to the Piaget (1983), children receive knowledge and they make changes on it according to their experiences and then they strengthened the knowledge. As a result, simulations provide good situations where this process can become since they have chance to convert their knowledge into action. Also, with simulation program, learners have chance to independently practice a variety of situation like real-life problems that they face in the future (Gagne, Wager & Rojas, 1981). According to Isman (2002), technology simplifies complex information for the students and it provides students opportunities learning by doing.

Computer simulations provide students to deeper learning. According to Schank (1986), there are different degrees to someone's learning with understanding which are making sense of something, cognitive understanding and level of complete empathy. Many times, learning may be limited to making sense. Computer simulations provide students to develop a deeper cognitive understanding. Vogel et al., (2006) found that games and simulations give rise to cognitive outcomes. Empathy is the final level of deep understanding. With this form of understanding students become parts of the simulation (Kerdeman, 1998).

This study reveals that computer simulations help students to visualize the network concepts and procedures. The feature of simulation program on providing visual

experiences to learners is very innovative and helpful in a way that it gives a chance to students to observe underlying processes, which is not possible in other methods. Therefore, simulation program increases high-level learning of students. Similarly, Bell and Garofalo (2006) say that simulations propose students empirical control to “observe, explore, recreate, and receive immediate feedback about real objects, phenomena, and processes.”

## **5.2 Limitations**

Because of the nature of qualitative research, following limitations were deemed necessary to mention in this study:

- 1- The qualitative data collected from participants through interview guideline was based largely on self-reported data and thus subjective-based. Therefore, the extent to which the validity and reliability of the findings of the study is based is predominantly dependent on the correct, sincere and honest responses given to the each interview questions.
- 2- The results drawn from the study after the data analysis procedures being adopted were examined and controlled by subject matter experts were highly depending on the interpretations of researcher.
- 3- Even if voluntary participation was sought for interview and permission was asked for use of data in the study, *Demand Effects* might have influenced students to become uncomfortable during interview and provide response to the questions which is more desirable for researcher.
- 4- Since students were immersed in computer network simulation during the courses extending over a large period of time, novelty effect was therefore likely to exist and lead students to be more interested.
- 5- Other factors such as the learning atmosphere including weather conditions, mood of the student, time, location, instructional strategies and methods being implemented by course instructor might have influenced the students’ perceptions and answers to the questions.

- 6- Technical problems in the computer laboratory were one of the main limitations of the study. Especially, connection problem in the internet prevent the downloading of laboratory manuals.
- 7- Results on this study were substantially self-reported.
- 8- The categories and themes are largely depends on interpretations of researcher.

### **5.3 Recommendations for Future Research**

Based on the comparison of the results explored in this study with the results reviewed from the literature, the following recommendations can be provided:

- 1- Since interest plays a very important role on students' participation to the course, the content of the computer network course together with course activities and tasks to be implemented during the course should be prepared and designed in accordance with their interest so that the course meets their needs.
- 2- Students who are working in the field of computer network are quite enthusiastic about and interested in learning a broad array of knowledge on computer network. Therefore, while preparing and designing a network course for such kind of people besides providing basic network information broad and thorough network information should be delivered to the students through authentic course activities.
- 3- Since the amount of information to be learned related to computer network varies from profession to profession, type and amount of the content to be covered in the course should be determined and geared towards the specific professional needs of members. For example, deep understanding of network knowledge may not be necessarily required for the members of the course coming from such professions as psychology and education. Instead, students whose profession is involved in applied science like engineering needs to

know network operations in detail and also are expected to have extensive knowledge on computer networks.

- 4- Increasingly emerging developments and innovations in computer and network technologies brings about a rapid transformation from industrial-age paradigm to information-age paradigm. General and basic information on computer network is no longer enough and adequate for students who want to get a job in their future life. Specific information is deemed necessary for development of particular skills which is the prominent requirement in the community of job industry. Therefore, as recommended by participants the network course should encourage development of particular professional skills and help students develop and acquire network knowledge which is widely applied in professional practices.
- 5- Participants complained about theoretical aspects of computer network course. According to them a part of network course is more theoretical and thus very difficult to comprehend and grasp its full meaning, especially in routing. Students should be exposed to more simulated activities which allow them to observe and examine the interrelationship among different network protocols, parts and concepts.
- 6- Participants indicated a great appreciation to visualization in computer network simulation. Abstract concepts in computer network seem to be a challenging part to understand. In order to teach such abstract concepts in computer network course more visualization/representation with varying types should be used to facilitate the understandings and development of such abstract concepts.

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## APPENDIX A

### CONSENT FORM (In Turkish)

Değerli Katılımcı,

Bu çalışma, Orta Doğu Teknik Üniversitesi (ODTÜ) Eğitim Fakültesi Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü Öğretim Üyesi Doç. Dr. Ömer DELİALİOĞLU ve master öğrencisi Halil GÜLLÜ tarafından yürütülmektedir. Çalışmanın amacı, ODTÜ Sürekli Eğitim Merkezi tarafından verilen MCNA programı kapsamında simülasyon programı kullanımının öğrencinin derse karşı tutum ve motivasyonuna etkisini incelemektir.

Çalışmaya katılım tamamıyla gönüllülük temelindedir. Çalışma ile ilgili anket doldurmanız mülakat sorularını cevaplamanız gerekmektedir. Ayrıca çalışma esnasında video ve ses kaydı alınacaktır. Cevaplarınız, video ve ses kayıtlarınız tamamen gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayınlarda kişisel bilgiler gizli kalmak koşulu ile kullanılacaktır. Katılım sırasında sorulardan, ses ve video kayıtlarından ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp çıkmakta serbestsiniz. Böyle bir durumda anketi uygulayan kişiye, anketi tamamlamadığınızı söylemek yeterli olacaktır.

Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz. Çalışma hakkında daha fazla bilgi almak için ODTÜ Eğitim Fakültesi Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü Öğretim Üyesi Doç. Dr. Ömer DELİALİOĞLU (Tel: 210 41 98; E-posta: [omerdelialioğlu@metu.edu.tr](mailto:omerdelialioğlu@metu.edu.tr)) veya SEM Bilgisayar Koordinatörü Halil GÜLLÜ (Tel: 210 35 47; E-posta: [ghalil@metu.edu.tr](mailto:ghalil@metu.edu.tr)) ile iletişim kurabilirsiniz.

*Yukarıda yer alan bilgileri okudum. Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum.* (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyadı

Tarih

İmza

## APPENDIX B

### INTERVIEW QUESTIONS (In Turkish)

Merhaba,

Ben ODTÜ Bilgisayar ve Öğretim Teknolojileri Bölümünde yüksek lisans yapıyorum ve şu an sizin de katkılarınızla bilimsel bir araştırma yapıyorum. Şimdi bu araştırmanın bir parçası olarak sana bazı sorular soracağım. Yalnız bu sorulara doğru ve gerçekten düşündüğün gibi cevap vermen bu araştırmanın güvenilirliği dolayısıyla bilimi yanıltmaması açısından çok önemli. Şimdi ODTÜ Sürekli Eğitim Merkezinde MCNA veya CCNA kapsamında verilen Bilgisayar Ağları Dersi ile ilgili sorular soracağım. Sorular oldukça basit. Bu sorular senin bilgini ölçmek için değil, tamamen bu dönem aldığımız Bilgisayar Ağları dersi hakkındaki düşüncelerini öğrenmek için. Verdiğin cevapları kesinlikle bir başkası bilmeyecek, sadece ikimiz arasında kalacak ve senin ismin geçmeden ben onu yaptığım araştırma için kullanacağım. Görüşme Esnasında sesinizi kayıt edeceğim. Ses kaydından çekinmene kesinlikle gerek yok, bu sadece sen konuşurken verdiğin cevapları yazmaktansa seni dinlemek istememden kaynaklanıyor. Yani, verdiğin cevapları kayıt edebilmem için gerekli. Mülakattan sonra bu kaydı dinleyerek cevaplarını yazılı hale getireceğim ve araştırmamda kullanacağım. İstersen şimdi sorulara geçebiliriz.

Hangi bölümde öğrencisiniz?

Kaçıncı sınıftasınız?

1. Sence herkes bilgisayar ağları konusunda bilgi sahibi olmalı mıdır? Neden?
2. Bilgisayar ağları konularını öğrenirken zorlandın mı? Neden?

3. Bilgisayar ađları ile ilgili ileri ( daha üst düzey) konuları öğrenmek ister misin? Nedenini açıklar mısın?
4. İleri de tekrar simülasyon tabanlı bir ders almayı düşünür müsün? Nedenini açıklar mısın?
5. Dönem boyunca karşılaştığın problemler nelerdir? Bu problemler daha sonra giderildi mi?
6. Arkadaşlarına bu dersi almalarını önerir misin? Nedenini açıklar mısın?
7. Ders süresince simülasyon programını nasıl kullandığını kısaca anlatır mısın?
8. Dersin simülasyon ortamında işlenen bölümü içeriđi öğrenmene katkıda bulundu mu? Bulunduysa nasıl anlatır mısın?
9. Simülasyon programı kullanımını süresince ne tür zorluklarla - problemlerle karşılaştınız?
  - a. Karşılaştığınız bu problemler öğrenme sürecinde sizi nasıl etkiledi?
  - b. Bu problemlerle baş edebilmek için ne tür stratejiler kullandınız?
10. Dersin beğendiđin özellikleri nelerdir? Nedenini açıklar mısın?
11. Simülasyonun kullanımını, konuları anlamanda yardımcı oldu mu? Nasıl?

## APPENDIX C

### LIST OF PARTICIPANTS' CODES USED FOR QUOTATIONS

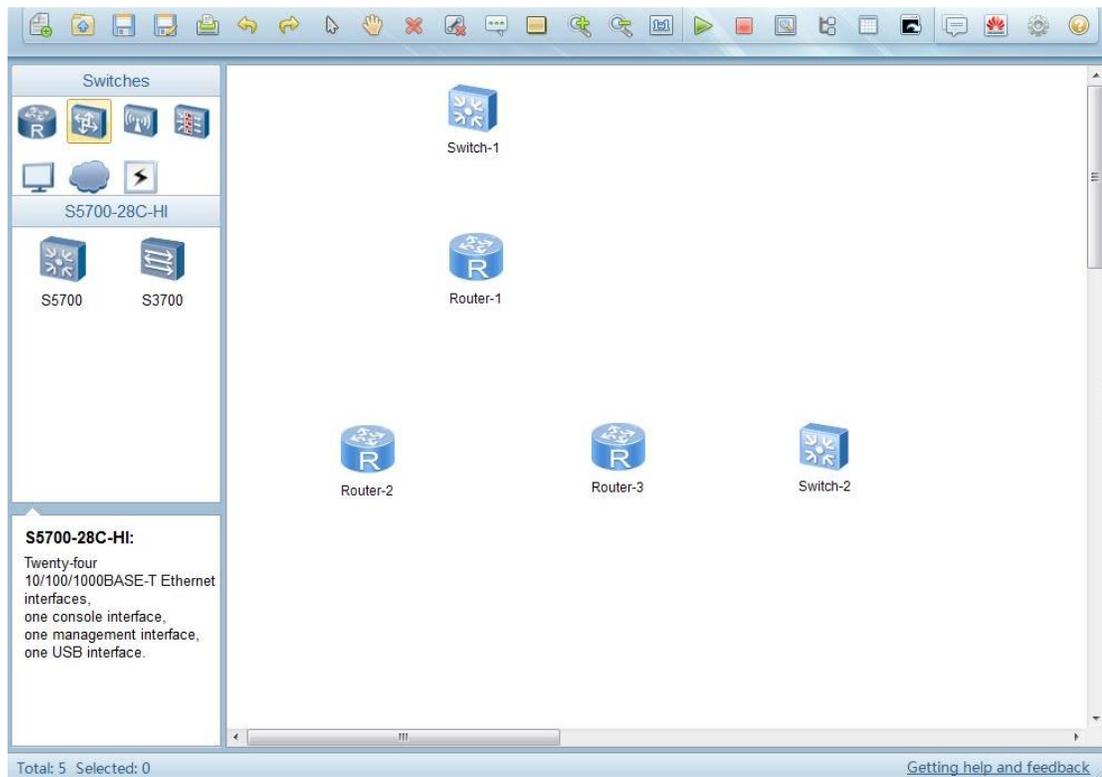
**Table C.1** List of Participants' Codes Used for Quotations

	Age	Gender	Nickname of Interviewee
<b>1</b>	21	M	C1P1
<b>2</b>	18	M	C1P2
<b>3</b>	18	M	C1P3
<b>4</b>	23	M	C1P4
<b>5</b>	23	M	C1P5
<b>6</b>	24	M	C1P6
<b>7</b>	22	F	C1P7
<b>8</b>	22	F	C1P8
<b>9</b>	21	F	C1P9
<b>10</b>	24	M	C1P10
<b>11</b>	32	F	C2P1
<b>12</b>	25	M	C2P2
<b>13</b>	29	M	C2P3
<b>14</b>	23	F	C2P4
<b>15</b>	24	M	C2P5
<b>16</b>	26	M	C2P6
<b>17</b>	37	F	C2P7
<b>17 Interviewees</b>		11 M, 6 F	

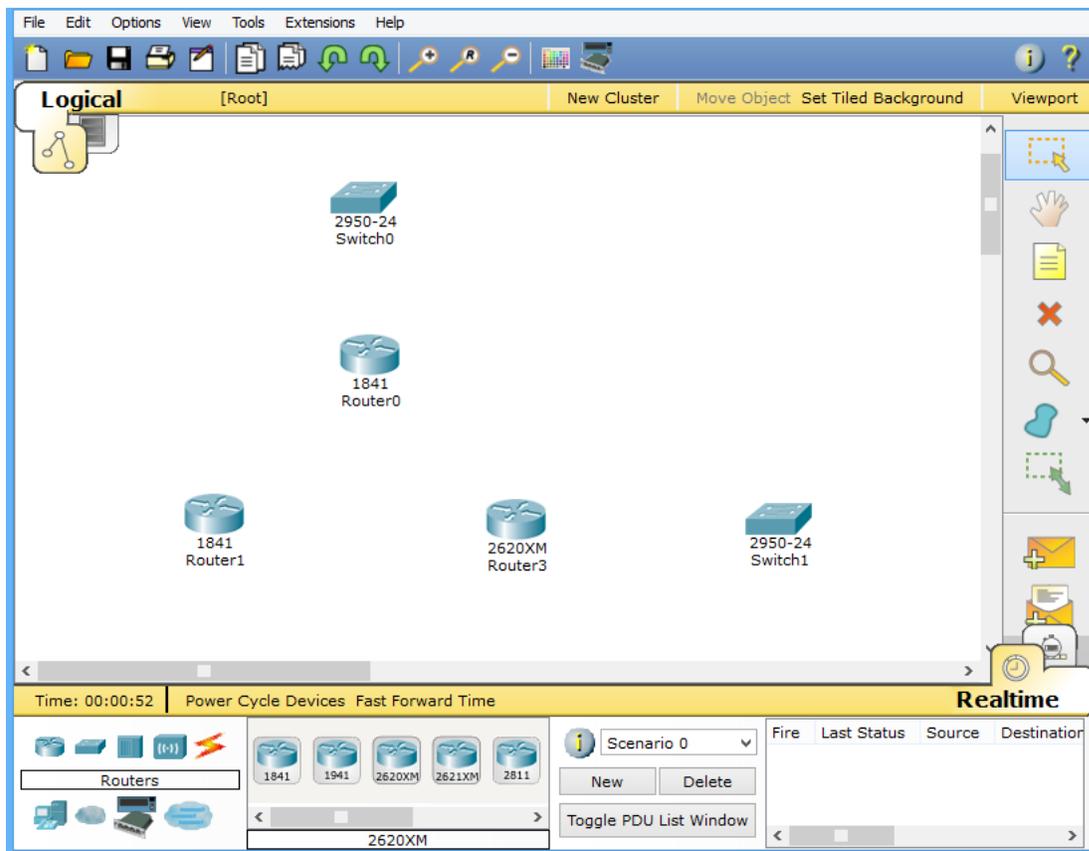


## APPENDIX D

### SCREEN CAPTURES OF SIMULATION PROGRAMS



**Figure D.1** Simulation Program for Course-1



**Figure D.2** Simulation Program for Course-2