THE EFFECTS OF INSTRUCTION WITH ANALOGY-ENHANCED MODEL ON NINTH GRADE STUDENTS' FUNCTION ACHIEVEMENT AND ATTITUDES TOWARD MATHEMATICS

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ABSTRACT

THE EFFECTS OF INSTRUCTION WITH ANALOGY-ENHANCED MODEL ON NINTH GRADE STUDENTS' FUNCTION ACHIEVEMENT AND ATTITUDES TOWARD MATHEMATICS

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This study was conducted to investigate the effect of analogy-enhanced instruction on students' achievement in function and attitudes toward mathematics.

The study was conducted with 63 ninth grade students in one of the public high schools in Konya, Turkey during Spring 2005 semester. The experimental group received instruction with analogy-enhanced model. The control group received instruction with traditional method. The matching-only pre-test- post-test control group design was used in the study.

The following measuring instruments were used to collect data: The Function Achievement Test, Mathematics Attitude Scale and open ended questions.

The data of the present study were analyzed by using Multivariate Analysis of Variance (MANOVA) and paired t-test. Results of the study indicated that: (1) There was a significant mean difference between students received instruction with analogy-enhanced models and those received instruction with traditional method in terms of the function achievement, (2) there was no significant mean difference between students received instruction with analogy-enhanced models and those received instruction with traditional method in terms of attitudes toward mathematics, (3) there was a significant mean difference between gained scores of students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitudes toward mathematics.

Key Words: Mathematics Education, Attitude Toward Mathematics, Function Achievement Test, Analogy-Enhanced Instruction, Traditional Instruction.

ÖZ

BENZETİM DESTEKLİ MODELLE ÖĞRETİMİN DOKUZUNCU SINIF ÖĞRENCİLERİNİN FONKSİYON BAŞARISINA VE MATEMATİĞE YÖNELİK TUTUMUNA ETKİSİ

AKMAN, Caner
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Eylül 2005, 88 sayfa

Bu çalışma benzetim destekli modelle öğretimin dokuzuncu sınıf öğrencilerinin fonksiyon başarısına ve matematiğe yönelik tutumuna etkisini araştırmaktadır.

Bu çalışma 2005 yılının bahar döneminde 63 tane dokuzuncu sınıf öğrencisiyle Konya'da bir devlet lisesinde yürütülmüştür. Çalışmada deney grubuna benzetim destekli model uygulanmıştır. Kontrol grubuna ise geleneksel yöntem uygulanmıştır. Çalışmada ön test ve son test kontrol grup araştırma tekniği kullanılmıştır.

Kullanılan ölçme araçları şunlardır. Fonksiyon Başarı Testi, Matematiğe Yönelik Tutum Ölçeği ve açık uçlu sorular.

Bu çalışmanın verileri çoklu varyans analizi (MANOVA) ve bağımlı (paired) t-test ile yapılmıştır. Çalışmanın sonucu şunları göstermiştir. (1) Fonksiyon başarısı açısından benzetim destekli model ile öğretim alan öğrenciler ile geleneksel yöntem ile öğretim alan öğrencilerin ortalamaları arasında anlamlı fark vardır; (2) matematiğe yönelik tutum açısından benzetim destekli model ile öğretim alan öğrenciler ile geleneksel yöntem ile öğretim alan öğrencilerin ortalamaları arasında anlamlı fark yoktur; (3) matematiğe yönelik tutum açısından benzetim destekli model ile öğretim alan öğrenciler ile geleneksel yöntem ile öğretim alan öğrencilerin ortalamalarının artış miktarında (gained scores) anlamlı bir fark vardır.

Anahtar Kelimeler: Matematik Eğitimi, Matematik Tutum Ölçeği, Fonksiyon Başarı Testi, Benzetim Destekli Modelle Öğretim, Geleneksel Öğretim.

To My Parents

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LIST OF ABBREVIATIONS

AEM	: Analogy-Enhanced Model
AEI	: Analogy-Enhanced Instruction
CG	: Control Group
EG	: Experimental Group
Fach	: Function Achievement
FAT	: Function Achievement Test
KEML	: Konya Endüstri Meslek Lisesi
MANOVA	: Multivariate Analysis of Variance
MAS	: Mathematics Attitude Scale
POSAC	: Post Achievement
POSATT	: Post Attitude
PREAC	: Pre Achievement
PREATT	: Pre Attitude
SPSS	: Statistical Packages for Social Science
TM	: Traditional Method
TI	: Traditional Instruction
TWA	: Teaching with Analogies

CHAPTER 1

INTRODUCTION

Students' construction of mathematical ideas during the course of problem solving is a fundamental goal of mathematics education (Davis, 1984; Schoenfeld, 1992). This knowledge construction is reflected in children's strategy development as they attempt to master a challenging problem situation (Erickson & Oliver, 1988). Research in the last decade has presented convincing evidence that children do behave strategically, they are able to direct their own learning, and can acquire knowledge of the domain in which they are working (e.g. Borton, 1992; De Loaches, Sugarman, & Brown, 1985; Gelman & Brown , 1986; Marten & Muher 1991).

One of the important role which has been a growing concern among educators for many years , is student motivation. Attracting student interest has always been a key in academics concern, but they have focused deeply in the area of motivation within the past decade. The rates of students are considered at risk of educational failure in mathematics. Studies have shown that there is a strong correlation between lack of student motivation and the rising number of at risk students in mathematics (Kasten & Howe, 1988). In this study, I attempted to increase students' motivation by using activities in analogs.

Although there are many students who are already motivated to learn, the number of poorly motivated students is substantial and seems to be growing (Klossterman, 1997). The latter are the students who fall into the risk category and educators should adopt alternative teaching strategies in order to prevent or at least reduce the number of these students. Traditional methods of instruction continue to work well with most students, but at risk students often present challenges in the classroom which often needs to be counteracted by educators. Knowledge and training of various motivational teaching methods is essential for an educator to be truly in teaching all students.

Traditional method used in most of mathematics classes does not allow students enough time to fully reach understanding. This study tried to show power of analogy understanding of new mathematics concept, function concept.

One aspect of the content-specific pedagogical knowledge is the use of analogies which can be often used to introduce new concept, by comparing them with something familiar or supporting political and philosophical arguments. The analogical thinking is an important cognitive skill which is beyond debate. Holyoake, June and Bilmann (1984) state that, Analogical thinking widely recognized as a hallmark of human intelligence, and as such, the course of its development is a topic of clear importance. During the last decades, the analogical researches have done about physiological and scientific area. Mostly everyone, including the experts, would agree that to create a mapping between items is one domain (often called as the source) to “similar” items in another domain (often called as target).

As is known, in learning a new subject, the background of the students’ knowledge is very crucial in mathematics. The knowledge can be generated by using analogy, which allows new material to be more easily assimilated with students’ prior knowledge, enabling them to develop more scientific understanding of concept.

Glynn (1991), Harrison & Treagust (1993), and Thiele&Treagust (1995) developed strong arguments for analogy model which is named teaching with analogy model (TWA). It was developed by examining the analogies of exemplary teachers and textbook authors. This model consists of six steps. According to Harrison (1992) TWA model can help the teacher to put subject in a sequence.

Analogical reasoning is a complex cognitive process that plays a central role in humans’ capacity. It helps to draw inferences about a novel phenomenon which based on their prior knowledge about a similar object. Specifically, analogical reasoning has been defined as the process of conceptually aligning two objects with high structural similarity and low surface similarity, and mapping between their correspondences such that the reasoned may draw inferences about a less well understood object from the better understood object (Gentner, 1983). Presenting unknown information in an analogy allows learners to actively approach the novel items by relating them to known phenomena, which is the reasoning practice that has been suggested to greatly improve learners' motivation, engagement, and encoding of new information (Gelman, 1994; Hartnett & Gelman, 1998)

Analogies are used to support understanding across the curriculum in a wide range of subjects for pupils of all ages. They are used in most areas of experience, from mathematics (Zhu & Simon, 1987) and science (e.g., Rouvray, 1994) to music (e.g. Stollack & Alexander, 1998) and language arts education (e.g., Huffbenkoski & Greenwood, 1995). The use of analogy in supporting understanding in science has been the focus of a significant amount of research (Duit, 1991, and Duit & Glynn, 1996), although most of this research has been with older students and adults. For example, Treagust et al. (1992) designed a study to examine how Australian high school teachers used analogies during their regular teaching sessions to aid students' comprehension of scientific concepts. Duit, Roth, Komorek and Wilbers (2001) have explored the use of analogical reasoning by Grade 10 physics students studying chaotic phenomena as part of a larger on-going project. Glynn (1991) has described a study of analogies used in elementary school, high school and college science texts. Thiele and Treagust (1994) used Curtis and Reigeluth(1984)'s framework to study analogies in high school chemistry texts. Later, they reported on a similar study of eight Australian senior high school chemistry texts (Thiele & Treagust, 1995).

The greater utility would be to train on students so that the training provides a meta-cognitive tool that facilitates their use of analogical reasoning techniques across dissimilar domains such as mathematics, physics, chemistry and biology.

Many teachers and textbook writers use analogies to help students to understand abstract mathematic concepts. The teacher or textbook author who chooses to use analogy to enhance student in the way they visualize the analogy and in the manner they map the analog-target attributes.

If the analogies apply correctly, it can be very useful for the students. Analogies have many advantages. They

- provide a bridge between prior knowledge and new information
- help students learning by providing visualization of abstract concepts
- increase motivation of the students in subject matter
- encourage teachers to take students' knowledge into consideration.

When the proper conditions are met, analogies can be applied to many subjects in mathematics. In this study, I tried to apply analogies in function achievement and attitude toward mathematics.

Haladyna and Shaughnessy (1983) noted that, a positive attitude toward mathematics is valued for the following reason: "(1) a positive attitude toward mathematics is an important school outcome in and of itself. (2) Attitude is often positively although slightly, related to achievement. (3) A positive attitude toward mathematics may increase one's tendency to elect mathematics courses in high school and possibly one's tendency to elect careers in mathematics or mathematics-related fields" (p.20).

According to Haladyna, the contribution of teacher to the achievements of students affects students positively. This study tries to improve the students' achievement by using analogy model, hence attitudes can be affected positively.

Consequently, the aim of the study was to investigate the effect of analogy-enhanced instruction on 9^{th} grade students on achievement in function and attitudes toward mathematics.

CHAPTER 2

REVIEW OF THE LITERATURE

In this chapter theoretical background for the analogy-enhanced model was explained and literature related the present study was reviewed and discussed.

2.1 Definition of Analogy

There are many definitions about analogies. Genter(1983) describe analogy as a type of reasoning where knowledge is transferred from one situation (called source or base) to another one (called target) on the basis of some kind of similarity between both situations, on the basis of the judgment that the two situations are essentially identical with respect to the task at hand. According to Hofstadter (1995) analogy can also be viewed as a kind of high-level perception, where one situation is perceived as (in terms of) another one. Vosniadou and Ortony (1989) describe analogy as "a move from one-place predicates that work on object attributes, to deep two-place predicates that involve object relations." Stepich and Newby (1988) describe analogy as an explicit, no literal comparison between two objects, or sets of objects that describes their structural, functional, and/or casual similarities. Some researchers contended that analogical problem solving may be an appropriate approach for generating solutions to problems which are often apparent within the domain of teaching (Dunn & Shriner, 1999). In fact, the concept of analogy goes back to the ancient Greeks. According to Esper(1973), the word analogy derives from the Greek "analogia" in which "ana" means collection of words or items and "logos" means reason.

Newton (2000) stated that analogies facilitate the transfer of relationship from the known to the unknown. He summaries this process, as shown in Figure 1;

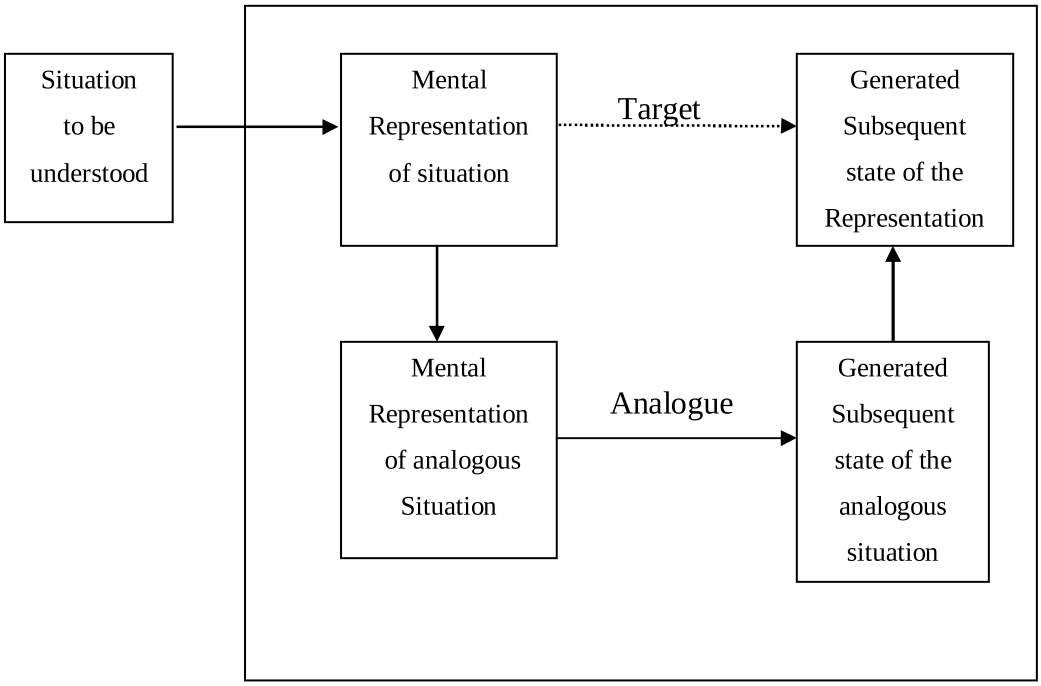

Figure1. The process of analogical reasoning (Newton, 2000, p.73)

The large, outer box encloses “in the head” processes (indicated by the four smaller inner boxes). The situation to be understood (the target) has to be mentally represented in some way. Manipulating this situation directly may prove difficult so this route (indicated by the broken line in Figure 1) is avoided. Instead, it is mapped onto a familiar parallel (the Analogue) which is manipulated mentally instead. The generated outcome (understanding) is translated into the situation under study. While there are many definitions of analogy in the literature (For example, Duit et al., 2001, Glynn, 1991; Treagust et al., 1992;), they all have in common this relationship between parts of the structures of two conceptual domains, the analogue and the target. The value of taking new ideas, information or experiences and relating them to a more meaningful context of organized knowledge has been well documented (for example, Ausubel, 1969; Gagné & Briggs, 1974; Gentner & Stevens, 1983; Halford, 1993; Johnson-Laird, 1983; Newton, D., 2000). Analogies can play a role in the restructuring of students’ conceptual frameworks (Duit et al., 2001), enhancing conceptual change learning and providing an analogical bridge to communicate content-specific knowledge of the topic (Treagust, Harrison, & Venville, 1998).

Aristotle defined classical analogies as comparisons among terms in the analogy, usually represented in the format of “A:B::C:D” (Goswami, 1992). The relationship between C and D terms should be equivalent to the relationship linking the A and B terms. The ability to conceptualize this quality of relations is recodynized as the “hallmark” of analogical. Similarly, Goswami (1992) discussed the phenomenon of “problem analogies” in which the characteristic of a solution for a base problem is applied to solve an analogous target problem. Goswami (1992) reported that children frequently were unable to see the intended relational correspondence between the base and the target problems, even though the relationship was evident to the experiments. For instance; 3:6::2:4 in this format the relationship between the three and six as similar with the relationship between the two and four.

When learners are confronted with unfamiliar material, provision of advance organizers and analogies are thought to enhance learning. Analogies promote learning by “concretizing” abstract concepts for the learner, promoting the assimilations of ambiguous or intangible concept (Newly & Stepich, 1987).

According to Halford (1992) much of human inferences is basically analogical and is performed by using schemas from everyday life as analogs. Analogy is a very natural aspect of human cognition; analogical reasoning would seem to lie at the very core of our cognitive process. It is even used by very young children under appropriate conditions (Brown, Kane, & Echols, 1986; Goswami, 1991).

2.2 Historical Background of Analogy

When the first theories of analogical reasoning were developed during the twentieth century, the theorist believed that analogical reasoning ability was a late appearing skill Piaget’s structural theory had the onset of analogical reasoning ability appearing between the ages of 12 and 15. Perhaps as a consequence, the use of analogies with younger children has tended to be ignored. But there was evidence to show that Piaget was wrong. Gelman and Markman (1987) had stated simple analogical reasoning amongst three and four years old. Children as young as five years used the needs of people as an analogy for the needs of plants (Hatano & Inagaki, 1994). According to Lynn (1993) analogy appears to be one of the most important mechanisms underlying human thought, at least from the age of about one year. He described the analogy as "a mapping from one structure, which is already known (the base or the source), to another structure that is to be inferred or discovered (the target)."

Curtis and Reigeluth (1984) devised a classification system for analogies in their study of secondary school science texts. In particular, they classified analogies according to the relationship between the *target* and the parallel situation that can be used to aid understanding, the *analogue*. They described the relationship as structural, functional or both. It is easier for a child to appreciate general structural and surface features, like shape and color. Such features provide a familiar model and this familiarity makes mental processing less demanding. At the same time relevant relationships are readily inferred because the model provides a mental structure. With functional analogies, the behavior or function of the target is modeled by the analogue. The assumption is that the learner is familiar with the analogue and, therefore, these functional parallels provide a mental structure for the target. Curtis and Reigeluth (1984) consider that the combination of both structure and function is particularly effective in that it is easier to match the components and that makes it easier to see parallels in the way they function.

True and consistent analogical reasoning, according to Piaget, required specific cognitive abilities. One was the child's ability to comprehend both lower and higher order relations between the object in a classical analogy. Another requirement for true analogical thinking for Piaget was that the child be certain of and consistent in the given response and resist the experimenter's counter suggestion (Piaget, Montenegro, & Billeter, 1977).

One of the earliest recorders instanced of analogy being used to solve a scientific problem was that of Archimedes. He was given the task of determining whether the king's intricately designed crown was pure gold or mixed with a base metal. The ultimate solution of melting the crown seemed unacceptable. Ever thoughtful, when Archimedes stepped into the bath and the tub overflowed, he had an analogical insight. Seeing that his body weight displaced a specific amount of water, Archimedes realized that a gold bar would do the same. One received this analogical insight, Archimedes is said to have run through the streets shouting "Eureka, eureka." All that was needed was a gold bar of the exact designated weight of the crown. If he put them in identical containers of equal amounts of water, and the crown and a gold bar displaced identical amounts of water, the crown was of pure gold. Legend has that it was (Goaswami, 1992; Halpern, 1984).

Although psychology and many scientific disciplines use analogies as illustrative device within the discipline, even process of scientific research involves analogical process (Oppenhimer, 1995). Many theorists support the importance of relating new knowledge to established, meaningful knowledge (Ausubel, 1969; Gagnè & Briggs, 1974). Analogy is commonly used as a teaching method in many areas like as physics, chemistry, biology, mathematics and etc. for teaching procedures and principles. It can be defined as "analogy is an assertion that a relational structure that normally applies in one domain can be applied in another domain" (Gentner, 1983). Analogies are perceived as having a worthwhile role in understanding unfamiliar knowledge by the association to the familiar ones (Curtis & Reigeluth, 1984; Keller, 1983; Reigeluth & Stein, 1983). Analogies are made motive students to the subject and help students learning by providing visualization of abstract concept (Treagust, Harrison,& Venville, 1998). Teachers can use analogies to introduce concepts in ways that are concrete, meaningful, and relevant to the students.

The role of analogy in learning has been extensively researched in science education. The core purpose of the use of analogy as a strategy deployed in teaching is that of developing understanding of abstract phenomena from concrete reference (Haywood, 2002). The use of analogy in developing understanding of phenomena is not restricted to science education. Dreistadt(1968) catalogues the central role of analogies in the history of science ideas, including the works of Einstein, Darwin, Bohr and Madeleev.

There is considerable research evidence, into the use of analogy in developing understanding in science across a range of phenomena in science education (Genter & Genter, 1983; Tiberghein, 1985; Wong, 1993). Analogical reasoning in science learning generally is explored in the work of Clement (1993) on a study with high school students' preconceptions in physics and Wong (1993) on trainee teachers' use of their own analogies in generating explanations of physical phenomena.

When teachers help students relate their background experience to new science concepts, they often use analogies, which is a similarity between concepts. For instance, the wing of a bird is analogous to the wing of an airplane. A human eye is analogous to the operation of a camera.

It is commonly accepted that children's mathematical learning is an active construction process based on recognizing similarities between new and existing ideas (Broody & Ginsburg, 1990; Davis & Maher, 1997; Duit, 1991). For children to construct the appropriate links to new learnings, they need to focus on the common relational structures of mathematical situations, rather than on their superficial details (English, 1997; Pierce & Gholson, 1994). This is where analogical reasoning comes into play that is, children have to map the relational proporties of a known construct (the base or the source) onto the corresponding proporties of a new construct (the target).

The search community has given considerable attention to reasoning by analogy in learning of science and in general problem solving (Clement,1993; Duit,1991; Genter 1989; Holyoak & Koh, 1987). However, little search has been directed toward its role in children's learning of basic mathematical concepts and in facilitating children's recognition and transfer of problem structures. This appears to be a serious omission, given that many of mathematical activities that children undertake in school require them to reason analogically and that such reasoning can contribute significantly to conceptual development during mathematical problem solving (English, 1997; Holyoak & Thagard, 1995; Novick, 1995; Silver 1990). According to English (1998) "An analysis of children's abilities to reason by analogy can provide new insights into the well-documented difficulties that they experience with complex operational word problems."

Children's difficulties with comparison problems have received substantial research, but few studies have investigated how children deal with these problems in a range of situations, including their ability to reason by analogy in working with more complex cases. Existing studies have usually employed a rather limited range of approaches to explore problem understanding (Cummins, Kintsch, Reusser & Weimer, 1988; Fuson, Carroll, & Landis, 1996)

Reasoning by analogy in problem solving and transfering has received a good deal of attention, but this has been mainly within the domains of science (Clement, 1993; Genter & Genter, 1983; Stavy & Tirosh, 1993), cognitive science, and cognitive development (Holyoak, 1985; Holyoak & Thagard, 1995; Robins & Mayer, 1993). Limited research has been conducted on reasoning by analogy in mathematical problem solving, and this dealt mostly with high-school and university students (Novick, 1992; Reed, 1987).

Successful representation of both source and target problems is one of the key underlying features to analogical transfer and can increase the probability of solving a problem successfully, decrease the time required for solutions and produce a better understanding of a class of problems not previously known (Wedman & Folger, 1999). The retrieval of source problems depends, in part, on similarities with the target problem either in surface characteristic, deep features, or both (Blanchette & Dunbar, 2000; Gick & Holyoak,1983)

2.3 Teaching with Analogies Model (TWA)

Ideally, analogies in text can help students to build meaningful relations between what they already know and what they are setting out to learn. In general, activity of building relations plays a critical role in constructivist views of learning science (Yager, 1995). In particular, this activity of building relations between existing knowledge and new knowledge plays an important role when interpreting students' learning as process of conceptual change (Demastes, Good & Peebles, 1996; Duit & Treagust, 1997; Hewson & Hewson, 1992). Increasingly, this change is being interpreted as students learning progressively more sophisticated mental models of fundamentally important science concepts (Cavallo, 1996; Glynn & Duit, 1995; Hafner & Stewart, 1995; White, 1995).Typically; these concepts represent complex system with interacting components. In this theoretical framework, familiar analogies can serve as early mental models which students can use to form limited but meaningful understanding of these complex concept. According to Glynn and Duit (1995), As the students develop cognitively and learn more science, they will evolve beyond these simple situated analogies, adopting more sophisticated and powerful explanatory models.

Gilbert (1989) noted that authors' analogies are often in effective, failing to increase students' recall of text information. Since, authors, lacking guidelines for using analogies, sometimes use them unsystematically, often cause confusion in students (Thiele & Treagust, 1994). The distinctions among a target concept, features of the concept, example of the concept, and an analogy become blurred in students' minds. The best way to solve these problems is to adopt guidelines for constructing and using analogies in science text. One source of guidelines is the Teaching with Analogies Model (TWA) (Glynn, 1991, 1995; Harrison & Treagust, 1993; Thiele & Treagust, 1995).

The TWA model was developed by examining the analogies of exemplary teachers and textbook authors. In this model, the goal is to transfer ideas from a familiar concept to an unfamiliar one. If the analog and the target share some similar features, an analogy can be drawn between them. The process of comparing the features is called mapping (Glynn, Duit, & Thiele, 1995). This model was employed into six steps. The value of six steps is simply to provide a kind of check list that a teacher can use to ensure that each phase has been adequately covered when an analogy is presented to a class. There are likely to be situations where a particular analogy is better presented sequence the steps of the model to suit their style. It is important that all six steps are adequately covered since it is believed that the six steps are a minimum for analogical instruction. If successful, the model should be personalized by teachers so that they are comfortable with the model and can economically apply it to each analogy used.

The six steps of the TWA model are follows (Glynn, Duit, & Thiele, 1995);

I. Introduce the target concept to be learned: This step can be anything from a brief introduction to a full explanation depending on how the analogy is to be utilized. The analogy may also be used for reviewing the concept in which case, the target concept is fully taught at this stage.

II. Cue the students' memory to the analogues situation: This step involves the introduction of the analog and determines the student level of familiarity through questioning and discussion. If the students understanding are low the analog is modified or the process is aborted. The teacher should ensure that there is at least one obvious similarity for the students between the analog and the target.

III. Identify the features of the analog that are relevant: This steps involves explaining the analog to the students at a level that is appropriate to their understanding an d which will accurately identify the features of the analog that will be used to build concept the next stage.

IV. Map the similarities between the analog and the target: The analogy features are linked with the target concepts. There may be a one to one correspondence from analog and the target, two or more analog features may converge on a single target concept or a single analog attribute may develop two or more target concepts.

V. Identify analog-target links where the analogy breaks down: During the mapping exercise, the students may suggest inappropriate links. Other invalid transfers that the teacher may be aware of can be combined with the students' alternative conceptions for discussion at this point. These conceptions should be discussed so that the students can distinguish the valid from the invalid. This step can be integrated into the discussion at any appropriate point.

VI. Summarize, drawing conclusion about the target concept: As in all teaching, a succinct summary of what has been learned about the target concept from the analogy should be stated to facilitate student learning.

Where the analogies break down in stage five is most significant feature (Harrison, 1992). Glynn's model is unique in highlighting this need to identify the invalid mapping links that students intuitively make. This activity may well dispel many of the student misconceptions that emerge during analogical transfer because analogies have no inbuilt guidelines that tell the hearer "no further please". This is a role the teacher can actively fulfill and so assist analogical instruction to achieve its full potential.

Analogies are most often used to help students to understand new topics in terms of already familiar information and to help them to relate that new information to their already existing knowledge structure (Beall, 1999; Glynn, 1991; Simons, 1984; Thiele & Treagust, 1991; Venville & Treagust, 1997). According to Lemke (1990) analogy work is very simple in thematic terms. An analogy sets up a simple correspondence between two thematic patterns. The patterns have different thematic items, but the same semantic relations between them. One pattern is already familiar, the other new. Students learn to transfer semantic relationships from the familiar thematic items and their pattern to the unfamiliar items and their pattern. (Lemke, 1990)

2.4 Advantages of Analogies

Analogies can play several roles in promoting meaningful learning. They can help learners to organize or view information from a new perspective. Thiele & Treagust (1991) argue that analogies help to arrange existing memory and prepare it for new information. Analogies can also give structure to information being learned by drawing attention to significant features of target domain (Simons, 1984) or to identify particular differences between analog and target domains (Gentner & Markman, 1997).

Analogies may also help students visualize abstract concepts, orders of magnitude, or unobservable phenomena (Dagher, 1995a; Harrison & Treagust, 1993; Simons, 1984; Thiele & Treagust, 1994; Venville & Treagust, 1997). When they do this, they provide a concrete reference that students can use when thinking about challenging, abstract information (Brown, 1993; Simons, 1984).

Analogies can also play a motivational role in meaningful learning. The use of analogies can result better in student engagement and interaction with a topic. Lemke (1990) asserts that students are three to four times more likely to pay attention to familiar language of an analogy than to unfamiliar scientific language. The familiar language of an analogy can also give students, who are unfamiliar or uncomfortable with scientific terms, a way to express their understanding and interact with a target concept. Analogies can make new material interesting for students, particularly when the analogy relates new information to the students' real world experiences (Thiele & Treagust, 1994). They can also increase students' beliefs about their problem-solving abilities when the new problem or new information are related by analogy to a problem or information they have already been successful in solving or understanding (Pintrich, Marx, & Boyle, 1993).

Analogies can play a role in promoting conceptual change by helping students to overcome existing misconceptions (Brown & Clement, 1989; Dupin & Johsua, 1989; Brown, 1992, 1993; Clement, 1993; Dagher, 1994; Mason, 1994; Venville & Treagust, 1996; Gentner , 1997). Ideally, analogies can help students to recognize errors in conceptions they currently hold, reject those conceptions, and adopt new conceptions that are in line with those accepted by the scientific community. Analogies may make new ideas intelligible and initially plausible by relating them to already familiar information. If students can assimilate new information in terms of their existing knowledge, they are likely to be able to understand that information, relate it in their own words, and comprehend how that new information might be consistent with reality all necessary conditions for conceptual change (Posner, Strike, Hewson & Gertzog, 1982).

2.5 Disadvantages of Analogies

As well as advantages, analogies may also have some negative result. For example, although both teacher and student may consider an analogy useful for learning new information, the analogy might be superfluous information if the student already has an understanding of the target concept being taught (Venville & Treagust, 1997).

Students may resort to use an analogy mechanically, without considering information the analogy was meant to convey (Arber, 1964; Gentner & Gentner, 1983; Venville & Treagust, 1997). Part of the mechanical use of analogy may be due to the students' not being willing to invest time to learn a concept if they can simply remember a familiar analogy for that concept, since familiar analogies can often provide students with correct answers to exam questions even when those analogies are not understood (Treagust, Harrison, & Venville, 1996).

The mechanical use of an analogy may also be due to students' inability to differentiate analogy from reality. An analogy never completely describes a target concept. Each analogy has limitations. Unfortunately, students usually do not know enough about the target concept to understand those limitations. For this reason, they may either accept the analogical explanation as a statement of reality about the target concept or incorrectly apply the analogy by taking it too far.

Although one of the purposes of an analogy is to help students to learn a concept meaningfully by relating that concept to the students' prior knowledge, the use of an analogy may limit a student's ability to develop a deep understanding of that concept (Brown, 1989; Dagher, 1995b; Spiro, Feltovich, Coulson & Anderson, 1989). When only one analogy is used to convey information about a particular topic, students may accept their teacher's analogical explanation as the only possible or necessary explanation for a given topic.

It is clear from the existing literature that not all analogies are good analogies and that not even a good analogy is useful for all students. With these advantages and disadvantages analogy was studied in function in mathematics.

2.6 Attitude toward Mathematics

Quinn (1997) defined attitude toward mathematics as the level of like or dislike felt by an individual toward mathematics.There is not so much study about attitude towards mathematics. Among few, Aiken (1972) found a positive correlation between mathematics achievement and attitude toward mathematics. He found some result, firstly there was a general variable of attitudes toward mathematics including attitude toward routine computations, terms, symbols, and word problems; secondly, there were gender differences in the direction and degree of relationship of mathematics attitude to interest in other subjects and personality characteristics; thirdly attitudes toward mathematics was positively correlated with grades in arithmetic and mathematics and lastly attitudes toward mathematics was related to students' perceptions of attitudes and abilities of their teachers and parents. Moreover, Perl (1982) emphasized that for both males and females ability and achievement in mathematics result in positive attitudes toward mathematics. There are some studies focusing on relationship between the students' mathematics achievement and students' attitude toward mathematics. On the other hand, some research literature has failed to provide consistent findings regarding the relationship between mathematics achievement and attitude towards mathematics (Abrego, 1966; Wolf & Blixt, 1981).

It's widely believed that a teacher's attitude towards mathematics affects students' attitude. Clark, Quisenberry, and Mouw (1982) noted that prospective teachers for lower grade levels have less favorable attitudes towards mathematics than prospective high school mathematics teachers. Since students tend to form lasting attitudes towards mathematics during their middle school years, it is essential that their teachers have a positive attitude towards mathematics (Anttonen, 1969; Callahan, 1971). Fielder (1989) explained that when concrete materials are used in mathematics lecture, both teachers and students report that they enjoy mathematics lecture more. Activities, one of the way for the teacher to create a positive attitude in math classroom.

Studies have also confirmed that attitudes play an essential role in learning mathematics (Armstrong & Price, 1982; Shaughnessy & Haladyna, 1983). McLeod (1992) suggested that affective issues play a central role in mathematics learning and instruction. When teachers talk about their mathematics classes they seem just as to report their cognitive achievements. Similarly, inquiries of students are just as likely to produce affective and cognitive responses; comments about liking (or hating) mathematics are as common as reports of instructional activities.

Fey (1980) claimed that although teachers' knowledge of mathematics and how to teach it were important; their beliefs about mathematics teaching had equal impact on students. In addition, Thompson (1984) found that teacher's beliefs on mathematics do influence how they teach mathematics. The teacher who feels insecure, who dreads and dislikes subject, can not avoid transmitting her feelings to the children. Furthermore, studies of Carpenter and Lubinski (1990) have indicated that teacher attitudes towards a subject influence both the instructional techniques the use and that these in turn may have an effect on pupil attitudes.

Besides, teachers' attitudes and effectiveness in mathematics, the students' family background is influential in learning even in the subject of mathematics, which may appear to be learned exclusively in school (Proffenberger & Norta, 1959; Alper 1963; Wang, Wildman & Callahan, 1996)

CHAPTER 3

METHOD OF THE STUDY

This chapter explains the main problem and hypotheses of the present study, research design, and subjects of the study, definitions of terms used in the study, statement of the variables, measurement instruments, procedures followed, and the tools used for analyzing the data.

3.1 Research Design of the study

The present study uses a matching only pre-test and post-test control group design, which is one of the methods of the quasi-experimental design (Fraenkel & Wallen, 1996). The Function Achievement Test (FAT) and the Mathematics Attitude Scale (MAS) were also administered during the study.

Table 3.1 Research Design of the Study

Group	Pre-test	Treatment	Post-test
CG	FAT, MAS	TI	FAT, MAS
EG	FAT, MAS	AEI	FAT, MAS

In table 3.1 the abbreviations have the following meanings: CG represents control group, which received instruction with the “Traditional Instruction” (TI); EG represents experimental group, which received instruction with the “Analogy-Enhanced Instruction” (AEI). The measuring instruments are Function Achievement Test (FAT) and Mathematics Attitude Scale (MAS).

3.2 Main Problem and Sub-problems and Associated Hypotheses

In this section the main problem and related sub-problems of the thesis are presented, and examined relevant hypotheses.

3.2.1 Main problem

The main problem of the present study is the following; what is the effect of analogy-enhanced instruction 9^{th} grade students on achievement in function and attitudes toward mathematics?

3.2.2 The Sub-problems

S1: What is the effect of analogy-enhanced instruction on achievement in function?

S2: What is the effect of analogy-enhanced instruction on attitudes toward mathematics?

3.2.3 Hypotheses

H1: There is no significant difference between mean scores of 9^{th} grade students received instruction with analogy-enhanced model and those received instruction with traditional method in terms of their achievement in function.

H2: There is no significant difference between mean scores of 9^{th} grade students received instruction with analogy-enhanced model and those received instruction with traditional method in terms of their attitude toward mathematics.

H3: There is no significant mean difference between gained scores of 9th grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of their attitudes toward mathematics.

As shown above, the hypotheses are defined in the null form. They will be tested at the level of significance (alpha=0.05) after the treatment of subject in the experimental and control groups.

3.3 Subject of the Study

This study was conducted three in weeks, comprised totally 15 lectures each being 45 minutes, in Spring 2005 in a public high school in Konya, Turkey. 63 9^{th} grade students in two classes participated in the study. 32 of the students were in the control group and 31 of the students was in the experimental group. All the students were tought the same mathematical content with the same textbook in the same period of time. The students were assigned to classes randomly by the school administrations when they started the 9^{th} grade.

3.4 Definition of Terms

In this section, some of terms that were used in the study are defined to prevent any misunderstandings.

1. *Function Achievement* refers to subjects' achievement scores on the "Function Achievement Test".

2. *Attitude Toward Mathematics* refers to subjects' attitude scores on the "Mathematics Attitude Scale"

3. *Analogy-Enhanced Model* refers to tools that are used to transfer to knowledge.

4. *Treatment* refers to the method of instruction; either instruction given by traditional method or instruction analogy-enhanced model.

5. *Control Group (CG)* refers to the group who received instruction with the traditional method.

6. *Experimental Group (EG)* refers to the group who received instruction with analogy-enhanced models.

3.5 Procedure

We explained the procedure of the study in this section.

3.5.1 Steps of the Study

1. The study began with the review of the literature about various aspects.

2. Before beginning of the study, all necessary permission were obtained from the Ministry of National Education.

3. The mathematic attitude scale (MAS) was developed by Aşkar (1986). The function achievement test (FAT) was developed by the researcher.

4. FAT was piloted 122 tenth and eleventh grade students in a public high school in December 2004, which allowed testing the reliability and validity of FAT.

5. Activities were prepared using appropriate analogy-enhanced model by taking into account the curriculum approved by National Board of Education.

6. The FAT and MAS were administered by the teacher before and after the treatment during a mathematics class period being being.

7. One teacher taught the control group and researcher taught the experimental group.

8. The treatment continued for three weeks.

9. The data obtained from the FAT and MAS during the study was analyzed and used in reaching conclusions about the problem.

3.5.2 Problems Encountered

During the administration the activities, there were some problems. Firstly, some students' parents from experimental group opposed the study, but the director of the school persuades them after a short conservation. Secondly, the students were not able to concentrate the activities at the beginning of the study, but later they liked to activities too much.

3.5.3 Choosing Group and Group Structure

Research suggested that groups should be formed to enable student's work together more effectively (Kutnick, 1994). Some, like Biott (1984), believe that there should be no fixed rule for group size. Others, for example, Benett and Dunne (1994), are very clear about group size. They point out that the number of children in a group will determine the number of lines of communication and suggest that "teams of for are ideal".

In this study the member of the groups almost equal, the experimental group had 31 students and control group had 32 students, and groups are heterogeneous in nature academically. Beginning the treatment the students were informed that they were responsible for all the analogs and quality of their group work would be evaluated.

3.6 The Development of the Activities

Activities incorporating analogy-enhanced model were used during the study in the experimental group. The teacher instructed traditionally in the control group. The use of analogy-enhanced models started each activity. Analogy-enhanced instruction was enrolled on the experimental group.

We have two main papers using the activities. The first one is general information papers and second one is functions papers. Now, I am going to explain these papers.

3.6.1 General Information Papers Activities

The analog was about the four departments in Konya Endüstri Meslek Lisesi (KEML). These departments were computer, librarian, journalism, and automotive department. All students are required to enter three years education. All the students have to take an apprenticeship at the end of the first year and second year (see Appendix B, page 70).

The administration of the KEML was reached an agreement with some company. For the students in the department of the computer, the administration reached an agreement with Casper, Hp and Vestel computer corporation; for librarian department they agree with public library, national library and library of university; for automotive students they agree with Honda, Renault and TOFAŞ automobile factory; and also for journalism department they agree with Akşam, Hürriyet, Milliyet, Sabah, Star and Vatan newspapers (see Appendix B , page71).

The students in the computer department have to take two summer practice first one is at the end of the first year, and second one is at the end of second year.

The students have to choose same company for the first year summer practice. But at the second year practice students can choose one of the companies they want, in addition to this, all the computer companies have to get at least one students as an apprentice. And this department has at least three students. (see Appendix B, page72)

Like computer students, the students in the department of librarian have to take two summer practices, too. But there is a difference between these departments. The students in the librarian department not only the fist but also have to choose the second summer practice at the same library. Students of this department love each other to much, so they take their practice all together at the same library (see Appendix B, page73)

The third one is the journalism department. Like other department these students have to take two summer practices, and they have to choose same company in the first year but the second year all the students have to choose different company. In addition to this, the administration restricted to number of the students with the number of the agreement newspapers. So, the number of the company is equal with the number of the students. There are six companies and six students (see Appendix B, page 74).

The last department is automotive department. The students in the department of automotive have to take two summer practices, too. Their practices are similar with computer department practice, but additionally agreement companies of this department can train the students in different areas in the factory. Honda Company steer the students towards engine department of the factory, Renault Company steer the students towards to train in car service and TOFAŞ Company steer them according to design department. In this way students can choose a company in their ability (see Appendix B, page 75).

All these departments are managed an administration. All the students have to obey the rules of the administration. These rules are

- Each department's students have to take two summer practices.

- All the students have to take these practices in their division not another one.
- The summer practices have been trained only the company which was reached an agreement with administration. Other companies are not accepted by them. (see Appendix B, page 76)

3.6.2 Function Papers Activities

Second part of the activities is function papers. These papers are going to be used after the regulations papers and each paper of the second activities is going to be used with regulations papers. The function papers activities are definition of function, kinds of function, inverse function and compound function. Now we are going to explain the activities;

3.6.2.1 Activities for Definition of Function

This activity sheet has an explanation for KEML, and has two sets, as KEML and companies. KEML includes four departments and set of companies has 15 companies. KEML have four departments as computer, librarian, journalism and automotive. All the departments have to get two summer practices one of them is at the end of first year and other one is at the end of the second year. The departments have to get practice in only their divisions, and also departments have to choose the same company on their divisions in the first year practice. For examples students of automotive department can choose only Honda, Renault and TOFAŞ (see Appendix B, page77).

3.6.2.2 Activities for Types of Function

In this section we are going to explain activities about the kinds of function.

3.6.2.2.1 One to One Functions Activity

First function is 1-1 function. The new analog and rules papers were used for the 1-1 function. As if analog of function definition, this analog has two sets, too. The first set is department of the KEML and other set is companies. Computer, automotive, librarian and journalism departments had to make their summer practice to different companies, hence a 1-1 function can be created by matching the elements of the KEML with elements of companies (see Appendix B, page 78).

3.6.2.2.2 Into Functions Activity

The second function is into function. The new analog and rules papers were used for the into function. As if analog of 1-1 function, this analog has two sets, too. First set is department of the KEML and other set is companies. The departments have to get practice in only their divisions, and also departments have to choose the same company on their divisions in the first year practice. Hence there are some free elements in set of companies (see Appendix B, page 78).

3.6.2.2.3 Onto Functions Activity

The third function is onto function. For this function a new analog paper was prepared. The new paper includes a short description about the second practice of computer department and it has two sets. One of the sets is the students of the computer department and other set is about the computer companies, Hp, Casper, and Vestel. In this function the students of computer department are domain of function and computer companies are range of function. All computer companies have to get at least one student as an apprentice. While matching these two sets there is no free elements in range of function, computer companies set (see Appendix B, page 79).

3.6.2.2.4 Constant Functions Activity

The fourth function is constant function. A new analog paper was used to describe constant function. This paper has a short commentary about librarian department, and also has two sets, first one is librarian department student as domain of function, and the second one is the libraries as range of function. . As we told before the librarian department's students took their second summer practice in the same library (see Appendix B, page 80).

3.6.2.2.5 Identity Functions Activity

The fifth function is identity (unit) function. For this function we did not use a new analog paper, but a mirror was brought to the lecture.

3.6.2.3 Inverse Functions Activity

After preparing the definition of the function and function assortment, we prepared a new activity. This analog included a short description about the journalism department and has two sets, students of the journalism department and newspapers. As if the computer department, the students in the department of journalism take their second summer practice in different newspapers, in addition to other departments, the members of the department are restricted with number of the agreement newspapers, and a newspaper gets only one students as an apprentice. So, the number of the company is equal with the number of the students. There are six companies and six students (see Appendix B, page 81).

3.6.2.4 Compound Functions Activity

The last activity was prepared for compound function. This analog included a short description about the automotive department and has three sets; first one is students in the automotive department, second one is companies, and third one is the departments of the factories. This analog focuses on the second summer practice of the automotive department students. Each factory has several department but they take in practice to the students only one department. For example, Honda Company steer the students towards engine department of the factory, Renault Company steer the students towards to train in car service and TOFAŞ Company steer them towards to design department (see Appendix B, page 82).

All those activities were prepared by the researcher before the treatment.

3.7 Development of the Measuring Instruments

In the present study, a function achievement test and attitude toward mathematics scale were administered.

3.7.1 Function Achievement Test

The Function Achievement Test (FAT) was developed by the researcher (see Appendix A). It was used to determine the student's function achievement before the treatment, to assess the students' degree of attainment of the course objectives and to test the equivalence of the experimental and control groups in terms of function before the treatment.

The section below explains the design procedure and the process used in developing the measuring instruments.

1. Course content was determined according to the curriculum program published by the Ministry of Education.

2. Objectives were written at the application level as defined by Bloom’s Taxonomy.

3. A table of specification was prepared.

4. An item bank was formed by writing different problems at the different cognitive levels in Turkish. They were classified by the researcher according to basic function concepts and levels in the cognitive domain of Bloom's Taxonomy.

5. Twelve problems were selected from the item bank according to the table of specification. The essay-type questions required the subjects. The problems were evaluated by using the answer key.

6. The content validity of the FAT with 12-questions was tested by a mathematics education researcher and a public high school mathematics teacher. Based on their comments, the test was reorganized. In addition, the content validity was tested by using the table of specification.

7. A pilot study was conducted to determine the validity and reliability of the test. 122 tenth and eleventh grade students in a public high school were chosen for the pilot study.

8. The FAT did not contain objective test items so that the rater reliability was investigated to eliminate the subjectivity. For rater reliability, the researcher and a mathematics educator scored the test administered in the pilot study. The correlation the two scoring was determined by running SPSS. The Pearson product moment correlation coefficient was performed. The correlation coefficient was found as 0.98.

9. The highest possible score for FAT was 71 marks.

3.7.2 Mathematics Attitude Scale

Mathematics attitude scale (MAS) was developed by Aşkar (1986) (see Appendix C). To develop this scale it was administered to 204 English Preparatory School students at METU. It was consisted of 10 positive and 10 negative items about attitude toward mathematics. They were in five-point Likert-type scale: Strongly Agree, Agree, Undecided, Disagree, Strongly Disagree. Positive items were coded starting from Strongly Agree a 5 to Strongly Disagree as 1. Negative items were coded as from 1 to 5. The scale was in Turkish and its alpha reliability coefficient was found as 0.96 with SPSS.

One factor was determined by using factor analysis, labeled general attitude toward mathematics. Also, the results of Principal Component Analysis supported that MAS was one-dimensional by using the SPSS package program. In this study, MAS is used to test the equivalence of experimental and control groups in terms of attitude toward mathematics before the treatment was started. The range of total scores of MAS is between 20 and 100.

3.7.3 Open Ended Questions

To get the information about views of students in the experimental group about the treatment the following questions were asked as a written questionnaire: (1) What do you think about activities related with function concept? (2) Did the activities change your views about mathematics?

3.8 Treatments

Different treatments were administered to the control and experimental groups. The control group received instruction from their own teachers, but the experimental group received instruction from researcher. The two groups were taught the same content to reach exactly the same objectives. These objectives covered basic concept of function including definitions of the function, kinds of function, inverse function and compound function. At the beginning of the treatment achievement and attitude pre-test was applied.

3.8.1 Treatments of the Control Group

The instruction given to the control group was called as traditional instruction because the instructor taught concepts and skills directly to the whole class. The subject was taught in a teacher centered way. The only interaction between students and the teachers occurred when the students asked questions. This class received 3 weeks instruction, 15 lectures each was 45 minutes. Students did not use concrete models in the control group. The control group was given the FAT and the MAS before and after the unit. The teacher explained to the students the purpose of the attitude scale and achievement test.

3.8.2 Treatment of the Experimental Group

The Experimental group was instructed using analogy-enhanced models. The experimental group received 3 weeks, 15 lecture each one 45 minutes, instruction. Before the treatment the students were explained the purpose of the treatment, procedures to be followed, expected collaborative behavior as well as the definition of group success. The teacher told the students that pairs work will be evaluated after the treatment.

In the experimental group the students work in pairs through the study. Their regular mathematics teacher formed the pairs. The pairs worked together, helped each other and shared to work in order to complete a task during the period. The students were encouraged to work in pairs, complete the analog, share concrete models, and share the work when writing the results with the class.

The activities were given to the students step by step. Before distributing the general information papers, includes seven pages, the teacher banded together them with a stapler, and then the teacher distributed all the general information papers to the students. Afterwards, the instructor introduced the pairs to these papers and said them to use the papers with main analog, function papers. After the general information papers, the instructor distributed the function papers one by one.

3.8.2.1 Definition of function

Firstly definition of the function analog was given to the students. This paper had an explanation for KEML, and had two sets, KEML and companies. This analog was worked with general information papers especially with the first page of papers. The teacher wanted pairs to match the department with companies according to general information papers and analog. (Appendix B). The groups wrote their answers on the papers and then they explained their thought to the class one by one. Afterwards the teacher instructed the mathematical definitions of the function. By using these definitions and their opinion groups gave the concrete examples and mathematical examples and then they told all the examples and discussed during the lecture.

After analog of the function description, kinds of function was instructed, so new analog was given to the students.

3.8.2.2 Types of Functions

The kinds of function are explained below. They are one to one function, into function, onto function and constant function.

3.8.2.2.1 One to one functions

First function was 1-1 function. The new analog and general information papers was used for the 1-1 function. As if function definition analog, this analog has two sets, too. First set is department of the KEML and other set is companies. Computer, automotive, librarian and journalism department had to make their summer practice to different companies, hence the students create a 1-1 function by matching the elements of the companies' set. And teacher asked what the 1-1 to function is. Pairs wrote answers and explained to the class. After getting the answers, instructor gave the mathematical definitions of the 1-1 function. So, pairs gave concrete and mathematical examples during the lecture. By using those examples instructor asked a few assessment in school textbook.

3.8.2.2.2 Into Functions

The second function was into function. The new analog and information papers were used for the into function. As if analog of 1-1 function, this analog has two sets, too. First set is department of the KEML and other set is companies. The departments have to get practice in only their divisions, and also departments have to choose the same company on their divisions in the first year practice. Teacher wanted students to match elements of the two sets by using the new analog and general information papers page1 and page 2. After matching the pairs release that there are some free elements in the companies' sets. And teacher explained the mathematical definitions of into functions. By using definitions and analogies the pairs gave concrete and mathematical examples and discussed the examples during the lecture with other pairs.

3.8.2.2.3 Onto Functions

The third function is onto function. For this function a new analog paper was distributed to pairs. The new analog included a short description about the second practice of computer department and it has two sets. One of the sets is the students of the computer departments and other set is about the computer companies, Hp, Casper, and Vestel. After distribution the teacher wanted to the students to match those sets according to analog and third page of the general information papers. Most of the pairs matched the elements correctly. Some of them did not make the matching correctly, but other pairs helped them for true matching. In this function, the set which includes students of the computer department is domain of function and computer companies is range of function. All the computer companies have to get at least one student as an apprentice, hence matching these two sets there is no free elements in range of function, computer companies set and the pairs realized that situation. Afterwards instructor explained the mathematical definitions of the onto function and then students gave concrete and mathematical examples. All the pairs discussed these examples on the lesson.

3.8.2.2.4 Constant Functions

The fourth function was constant function. A new analog paper was used to describe constant function. This paper has a short commentary about librarian department, and also has two sets, the first one is librarian department student as domain of function, and the second one is the libraries as range of function. . As we told before the librarian department's students took their second summer practice in the same library. So elements of the librarian had to match with the same element in the set of library. Instructor wanted the pairs to match the elements of the set according to new analog and fourth page of the information papers. And then students realized that all the elements in domain of function were matched with only one element in the range of function. Afterwards instructor explained the mathematical definitions of the constant function and then students gave concrete and mathematical examples. All the pairs discussed these examples in the lesson.

3.8.2.2.5 Identity Functions

For this function we didn't use the analogy papers. The instructor brought a mirror to the class and wanted the students to look at the mirror, then asked them what they realized in the mirror. Pairs answered that they realized themselves in the mirror. By using this most of the pairs predicted the description of identity function. Afterwards the teacher explained the definitions of the identity function, by using this definition pairs gave concrete and mathematical example, then examples discussed during the lecture.

3.8.2.3 Inverse Functions

After teaching the definition of the function and function assortment, instructor used inverse function activity which was about the second practice of the journalism department. The instructor distributed this analog and wanted the student to study with the fifth page of the information papers. As if the computer department, the students in the department of journalism took their second summer practice in different newspaper, in addition to other departments, the members of the department were restricted with number of the agreement newspapers, and a newspaper got only one student as an apprentice. So, the number of the company is equal with the number of the students. There were six companies and six students. According this information groups matched the elements of the first set with the elements of the second set. In this way there was no free element in set of students and set of newspapers. After matching the sets, groups classified the set of journalism department as domain of function and called set of newspapers as range of function. . And then opposite of the first matching, teacher wanted students to match second set with the first one. Suddenly, the students noticed that domain of function and range of function were inverted. Now, journalism department students were range of function and newspapers were domain of function. Afterwards, teacher told the mathematical definition of the inverse function, and then the students gave a concrete example and a mathematical example, and then all the pairs shared their examples with class and discussed.

3.8.2.4 Compound Functions

Our last treatment was about compound function. The activity, which was about the second practice of the automotive department, was distributed. The instructor wanted to use this analog with sixth page of the information papers. Each factory has several departments but they take in practice to students only one department. For example, Honda Company steer the students towards engine department of the factory, Renault Company steer the students towards to train in car service and TOFAŞ Company steer them towards to design department. If a student wanted to practise in engine service, he has to choose Honda Company. According this information pairs matched the sets and discussed during the lecture. Afterwards the instructor explained the mathematical definitions of the compound function.

3.9 Variables

Three variables were considered in the present study. One of them was independent variable and others were dependent variables. The independent variable was the treatment.

The dependent variables were;

1. Function achievement
2. Attitudes toward mathematics.

3.10 Data Analysis

We analyzed the data of the present study using the following statistical techniques. The FAT did not contain objective test items so that the rater reliability was investigated to eliminate the subjectivity. For rater reliability, the researcher and a mathematics educator scored the test administered in the pilot study. The correlation the two scoring was determined by running SPSS. The Pearson product moment correlation coefficient was performed. T-test was used to test pre-treatment mean differences between treatment groups in terms of function achievement and attitude toward mathematics. After the treatment Multivariate Analysis of Variance (MANOVA) was used to test the effect of instruction with analogy-enhanced model on achievement in function and attitudes toward mathematics.

3.11 Assumptions and Limitations

As in other studies there are several assumptions and limitations in the present study.

3.11.1 Assumptions

The main assumptions of the present study are the following;

1. There was no interaction between the experimental and control groups to affect the results of the study.
2. The teachers were not biased during the treatment.
3. The administration of the tests and scales were completed under standard conditions.
4. All subject of the pilot study answer the measuring instruments accurately and sincerely.
5. All subjects of the control and experimental groups answered the measurement instruments accurately and sincerely.
6. No outside event occurred during the study to affect the beliefs of the subject.

3.11.2 Limitations

The limitations of the present study are as listed below:

1. This study was limited to 9^{th} grade students in a public high school in Konya-Turkey during the spring semesters of 2004-2005 academic year.
2. The study was limited with only 63 students.
3. The study was limited to unit of function concept.
4. Self-report techniques, which require the subject to respond truthfully and willingly, were used.
5. The students in the experimental group studied with pair, but scores was evaluated for each student.

CHAPTER 4

RESULT AND CONCLUSION

In the previous chapters, the theoretical background of the study, the review of the previous studies and the method of the study were stated. In this chapter, the results of the analyses of pre-treatment and post-treatment measures with respect to treatment. And also conclusions are presented. Hypotheses were also stated as a null form and tested at the alpha level of significance 0.05.

4.1 The results of Pre-treatment Measures with Respect to Treatment

Before the treatment the function achievement test (FAT) and mathematic attitude scale (MAS) were administered to the subjects. The results of the t-test are presented in Table 4.1

Table4.1 The Results of the t-test

Variables	TM		AEM		t-value
	Mean	SD	Mean	SD	
FAT	10.93	5.23	9.35	7.47	.976
MAS	77.46	17.59	72.9	21.23	.931

As seen in table there is no significant mean difference between students who received instruction with analogy-enhanced models and those received instruction with traditional method in terms of function achievement and attitudes toward mathematics before the treatment ($p>0.05$).

4.2 Results of the Hypotheses of the problem

The problem of the study is the effect of analogy-enhanced instruction on achievement in function and attitudes toward mathematics.

The hypotheses of the study were;

H1: There was no significant difference between mean scores of 9^{th} grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of achievement in function.

H2: There was no significant difference between mean scores of 9^{th} grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitude toward mathematics.

To examine the problem of the study, H1 and H2 were tested by Multivariate Analysis of Variance (MANOVA). It shows that there were overall significant difference between mean scores of 9^{th} grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of achievement in function and attitudes toward mathematics.(Wilks' lamda=0.035, $p<0.05$). To see where the difference occurs, the univariate F-test was performed. The results are given in Table 4.2

Table 4.2 Result of the analysis

Source	Dependant Variable	Type 3 Sum Of Squares	Df	Mean Square	F	Sig.
Group	POSAC	4059.479	1	4059.479	33.19	.000*
	POSATT	450.487	1	450.487	1.63	.206
Error	POSAC	7458.839	61	122.276		
	POSATT	16791.069	61	275.263		
Total	POSAC	91590.000	63			
	POSATT	424934.000	63			

*$p<0.05$

As seen in the Table 4.2 it is found that there is a significant difference between mean scores of 9th grade students received instruction with analogy-enhanced method and those received instruction with traditional method with respect to achievement in function in the favor of AEM (analogy-enhanced method)($p<0.05$). The mean of the students received instruction with analogy-enhanced method is higher than mean of those who received instruction with traditional method. Mean of the students received instruction with analogy-enhanced method is 43.806 and standard division is 12.87. Mean of the students received instruction with traditional method is 27.75 and standard division is 8.951.

On the other hand there is no significant difference between mean scores of 9th grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitudes toward mathematics ($p>0.05$). However, the mean of the students received instruction with analogy-enhanced method is higher than the mean of the those who received instruction with traditional method. Mean of the students received instruction with analogy-enhanced method is 83.161 and standard division is 16.317. Mean of the students received instruction with traditional method is 77.812 and standard division is 16.851. The results of the FAT and MAS are presented in Table 4.3 and Table 4.4

Table 4.3 Result of the FAT

Treatment	PREAC		POSAC	
	Mean	SD	Mean	SD
TM	10.93	5.23	27.75	8.95
AEM	9.35	21.23	43.81	12.87

$p<0.05$

Table 4.4 Result of the MAS

Treatment	PREATT		POSATT	
	Mean	SD	Mean	SD
TM	77.46	17.59	77.81	16.85
AEM	72.90	21.23	83.16	16.31

$p<0.05$

In the study there was another hypothesis. It is following that;

H3: There is no significant mean difference between gained scores of 9th grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitude toward mathematics.

To examine the gained score of the study, H3 was tested by paired t-test. It shows that there is a significant mean difference between gained scores of 9th grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitude toward mathematics ($p<0.05$).

For experimental group it is found that the mean of the pre mathematics attitude test is 72.903 and standard division is 21.234; on the other hand the mean of post mathematics attitude test is 83.161 and standard division is 16.317. ($p<0.05$). Hence, there is a significant gain at MAS for experimental group.

For control group we found the mean of the pre mathematics attitude test is 77.468 and standard division is 17.590 and on the other hand the mean of post mathematics attitude test is 77.821 and standard division is 16.851. ($p>0,05$). Hence we can say that there is no significant gain at MAT for control group.

4.3. Conclusions

In the light of the above findings obtained by testing of each hypothesis, following conclusions can be deduced;

1. There is no significant mean difference between students who received instruction with analogy-enhanced models and those received instruction with traditional method in terms of function achievement and attitudes toward mathematics before the treatment.

2. There is significant difference between mean scores of 9^{th} grade students received instruction with analogy-enhanced method and those received instruction with traditional method with respect to achievement in function in the favor of AEM (analogy-enhanced model).

3. There is no significant difference between mean scores of 9^{th} grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitudes toward mathematics

4. There is a significant mean difference between gained scores of 9^{th} grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitude toward mathematics in the favor of experimental group.

CHAPTER 5

DISCUSSION

This chapter includes discussion and interpretation of the findings reported in the previous chapter and implications for further research studies. In the discussion researcher will also combine his own observation with the interpretation of the results.

5.1 Discussion

The purpose of this study was to investigate the effectiveness of the instruction with analogy-enhanced methods on students' mathematics achievement and attitudes toward mathematics. Data was gathered from ninth grade group mathematics classes using analogy-enhanced methods with the experimental group, and using traditional methods in the control group. Achievement was measured using a function achievement test (FAT) developed by the researcher, and attitude was measured using a mathematics attitude scale (MAS) developed by Aşkar (1986).

5.1.1 Functions Achievement

In this study, a pre-test was given both the experimental and the control group. It showed that there was no statistically significant mean difference between experimental and control group with respect to function achievement. The mean of the experimental group was 9.354 and standard division 7.472; the mean of the control group was 10.937 and standard division 5.236. The same test was administered to all students as a post-test after the treatment to investigate and effectiveness of the analogy-enhanced method. At the end of the treatment, the experimental group had a significantly high mean score on the function achievement test (FAT) with the mean of 43.806 and standard division of 12.877; control group was the mean of 27.750 and standard division of 8.951.

The results of the present study regarding the effectiveness of analogy-enhanced models in learning of function are supported with findings of previous research studies. For examples Goswami (1991) and Halford (1992) recommended that analogy-enhanced model was very valuable under appropriate conditions. Lynn (1991) declared that if the TWA model applied successfully, learning of the students could be improved during the lesson.

Glynn and Takahashi (1998) have applied an experimental science study on 58 eighth grade students. In experimental group they instructed an animal cell using an analog about a factory. Their analogy provided a bridge between cell and factory. Different people in the factory work at machines doing different jobs. Likewise, each part of the cell has a special job. In control group they instructed traditional method. After the treatment they found significant difference in favor of experimental group.

The improved results on the achievement test in the experimental group can be explained by the analogy-enhanced method which is used in this group. Analogies can result in better student engagement and introduction. Thiele and Treagust (1994) noted that analogies can make new material interesting to student, particularly when the analogy relates new information to the students' real word experiences. In this note Thiele and Treagust supported idea of Pintrich, Marx and Boyle (1993) when they declared that importance of analogy-enhanced model to learn new topic.

At the end of the treatment, students in the experimental group answered open-ended questions about the analogy-enhanced models. Most of the students said that analogy-enhanced model was understandable and have concrete examples. Students stated that they were more willing to ask questions of their classmates than they would be in a large class discussion with a teacher. They told that every one in the pairs participated in the class. They noted that they can match the concrete examples of the topic with exact definitions. Most of them found learning activities used in the study enjoyable, helpful and creative.

While instructing to function concept with analogies, I focused on TWA model. By using these six steps I dispelled many of the students' misconception. First the target concept was introduced, and then we introduced analogs and determine the level of the students' function concept. Third, we explained the analogs, and then we mapped the similarities between the analog and the target. Fifth, we identified analogy-tarots links where the analogy breaks down. Lastly we summarized and drew conclusion about the target concept. According to Glynn (1991) the best way of preventing confusion is these guidelines. Harrison and Treagust (1993) confirmed the idea of Glynn.

The result of the questionnaire showed us positive effects of analogy-enhanced model on students and these effects can be seen in the function achievement test. As I mentioned before there was a significance mean difference between the groups.

5.1.2 Attitudes toward Mathematics

At the beginning of the study, mathematics attitude scale was given both experimental and control group as a pre-test to measure subject attitude toward mathematics. It was showed that the mean of the experimental group was 72.903 and control group was 77.468; and also the standard deviation of experimental group was 21.232 and control group was 17.590. The same test was administered after the treatment all the students as a post-test to investigate of the effects of analogy-enhanced method on attitude toward mathematics. At the end of the treatment we did not find a significant difference between mean scores of 9^{th} grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitudes toward mathematics. We found the mean 83.161 and standard division 16.317 for experimental group and also we found the mean 77.812 and standard division 16.851 for control group. On the other hand we considered that there was a significant means difference between gained scores of 9th grade students received instruction with analogy-enhanced method and those received instruction with traditional method in terms of attitude toward mathematics in favor of experimental group.

The duration of treatment was short to make great change in attitudes toward mathematics of the students in experimental group. A long term study could cause the better results in attitudes of students who received analogy-enhanced instruction.

After the treatment we made a short questionnaire to the students in the experimental group, about their beliefs on instruction with analogy. Almost all students declared their gladness. One of the students told that she came to school only mathematics lesson in some days. Other one said that learning of function with analogy-enhanced model was a game and most of the students wanted me to instruct other subject by using analogy-enhanced model. Hence, I can say that this model improves students’ motivation during the lecture and they concentrate to learn new topic. We can see these differences on gained scores of experimental groups.

The results of the study supported by the findings of Fielder (1989), focused on the importance of concrete materials during the instruction of mathematics. Bayram (2004) found the same results with this study. But she studied with concrete models. She did not find a change in attitudes towards geometry in the course of the study in groups. But as mentioned before, the study conducted only three weeks, may be increasing to times of the treatment could be improved the attitude toward mathematics.

5.2 Recommendations

Following were stated to statistical analysis of the study and researcher’s experiences during the study.

1. Mathematics teachers should have a previous knowledge of the students to eliminate learning difficulties.

2. Activities involving the use of analogy-enhanced model should be developed and varied.

3. The class time should be planned carefully to give feedback to the groups.

4. During the treatments the instructor should give daily life examples the topics.

5. Teachers become more effective if they use analogy-enhanced instructions.

6. The present study focused on the only 9th grade students, so the findings reported cannot be generalized to other grade levels. Moreover it is limited only with function concept because of that the results can not be generalized with other concepts of mathematics.

7. There was only 63 students in the study, further studies can include more pupils.

8. For further researchers, different mathematics subject can be chosen for analogy-enhanced methods.

9. Long term of studies can be conducted to investigate effect of analogies on mathematics achievement.

10. Long term of studies can be conducted to investigate effects of analogies on attitude toward mathematics.

11. The further studies should be conducted to reduce the misconceptions which are related to analogies.

12. A study can be conducted to evaluate students' attitudes toward analogies.

13. The further studies should be careful on guidelines of TWA models.

14. A study can be conducted to assess the effectiveness of analogy-enhanced instruction and traditionally designed instruction as compared other situational methods.

5.3 Internal and External Validity

In this section we are going to discuss the internal and external validity of the study.

5.3.1 Internal Validity of the Study

Internal validity of a study means that observed differences on the dependent variable are directly related to the independent variable, but not due to some other unintended variable (Frankel & Wallen, 1996). In the present study, the possible treats to internal validity were location, data collector characteristics, data collector bias, confidentiality and subject characteristics.

The research results were not been effected by the grade level of the students, because all the students in the study were ninth grade level. A few students in both experimental and control group were attending a course outside the school. But the numbers of the students were not more than five.

The testing locations, i.e. classrooms were the same in terms of physical conditions. Classrooms were at the same building having the same positions.

Data collector characteristics and data collector bias would not be treats of the present study. The researcher who is the mathematics teacher of the classes instructed the experimental groups. The other mathematics teacher instructed the control group. The researcher and the other teacher followed the same mathematics program prepared by the Ministry of Education. Only the researcher taught the experimental group, the control group did not affect from the possible bias of the researcher. All the data was analyzed by the computer.

The name of the subjects were taken only for matching the pre-test and post-test results and kept secret. The students were informed about the secrecy of the results. Hence, confidentially was satisfied.

5.3.2 External Validity

The external validity is the extent to which the results of a study can be generalized. The subjects of the study were selected from one of the public schools in Konya-Turkey. Convenience sampling was used, so generalization of findings of the study was limited. The treatments and tests were given in regular classrooms settings similar classroom conditions.

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APPENDIX A

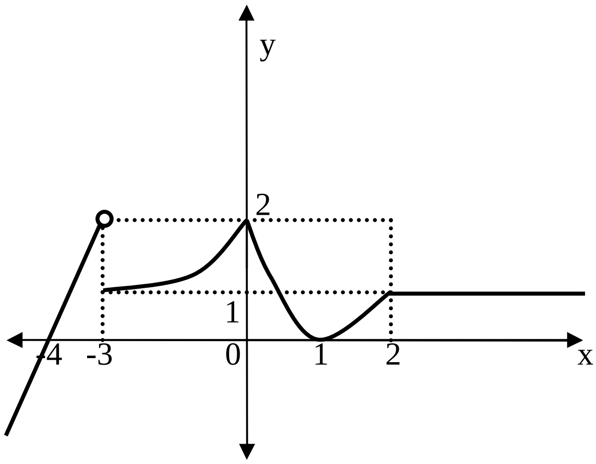
FUNCTION ACHIEVEMENT TEST

1) $A=\{-2,-1,0\}$

$f:A\rightarrow R$ $f(x)=x^2-3x$ fonksiyonu veriliyor buna göre $f(A)$ görüntü kümesini bulunuz.

---

2)



Yanda grafiği verilen f(x) fonksiyonunu kullanarak $f(-3)+f(1)+f^{-1}(2)$ toplamının sonucunu bulunuz.

---

3) $f:R-\{a\}\rightarrow R-\{b\}$

$f(x)=\dfrac{x-3}{x+4}$ bağıntısı birebir ve örten fonksiyondur. Buna göre a-b kaçtır?

4) $f: R-\left\{\frac{2}{3}\right\} \to R-\left\{\frac{1}{3}\right\}$

$f(x)=\dfrac{3x+a}{9x-6}$ fonksiyonunun sabit fonksiyon olması için a ne olmalıdır?

---

5) $f: R \to R$ ye $f(x)=3x+a$ ve $g(x)=bx+2$ olmak üzere , $(fog)(x)$ fonksiyonu birim fonksiyon ise a ve b değerlerini bulunuz.

---

6) $f: R \to R$, $g: R \to R$ olmak üzere iki fonksiyon veriliyor.

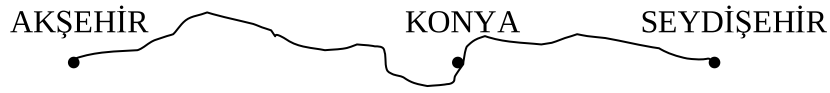
$f(x^2+3)=2x-1$, $g^{-1}(3x+1)=x+2$ olduğuna göre $\left(fog^{-1}\right)^{-1}(3)$ kaça eşittir?

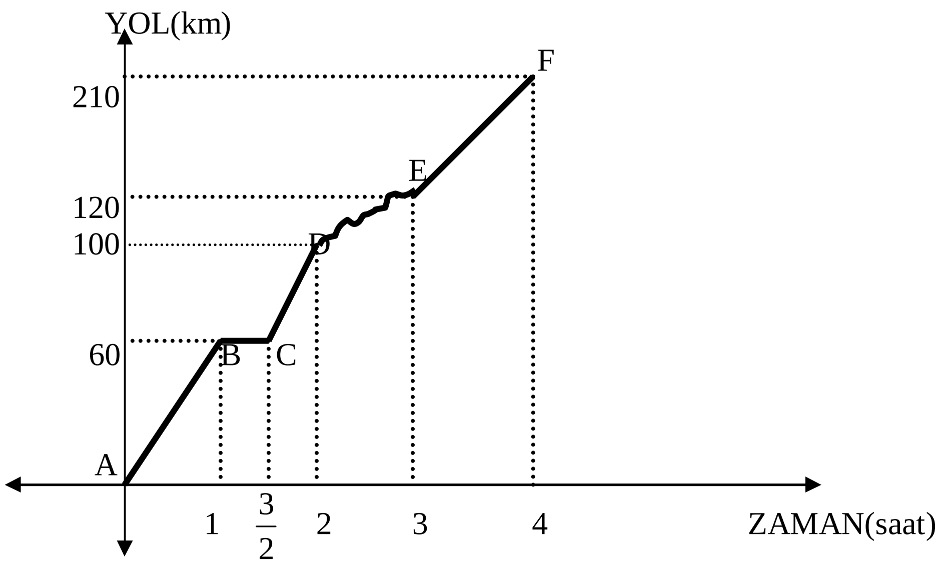
7) Fonksiyon kavramını açıklayınız, matematiksel bir örnek veriniz, gerçek hayattan somut bir örnek veriniz.

8) Ters fonksiyon kavramını açıklayınız , matematiksel bir örnek veriniz, gerçek hayattan somut bir örnek veriniz.

9) Bileşke fonksiyonun kavramını açıklayınız, matematiksel bir örnek veriniz, gerçek hayattan somut bir örnek veriniz

10)





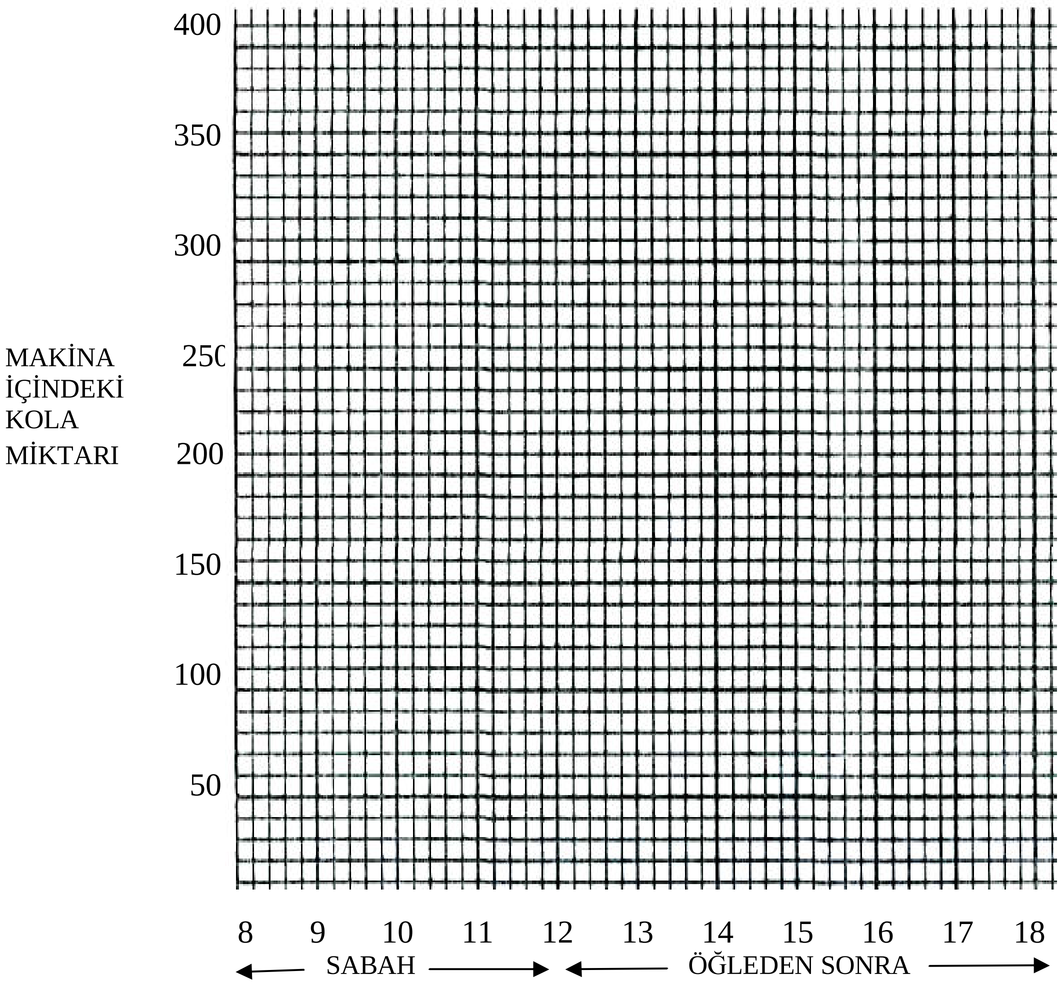
Yukarıdaki harita ve grafik Akşehir'den yola çıkıp Seydişehir'e giden bir aracın seyahatini göstermektedir.

Grafik ve haritayı kullanarak A'dan B'ye ; B'den C'ye ; C'den D'ye; D'den E'ye ve E'den F'ye yollarında aracın ortalama hızını bulunuz ve bu aralıklarda neler olduğunu (aracın bu aralıklardaki konumunu) açıklayınız. (A,B,C,D ve E noktaları Akşehir ile Seydişehir arsındaki bölgeleri göstermektedir.)

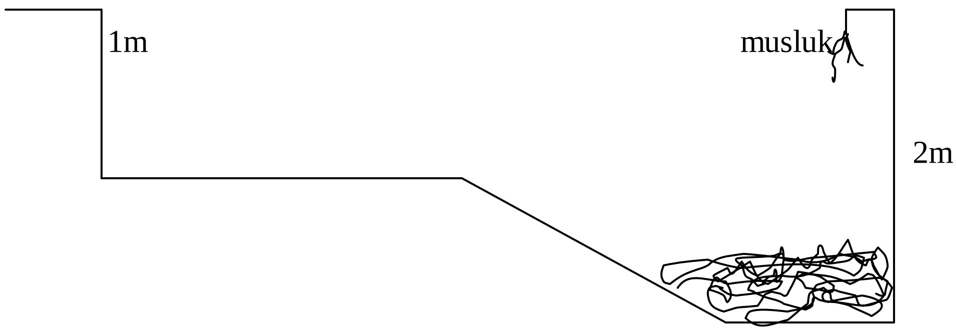
11) Okulumuzun kantinine bir kola makinesi kuruluyor;

- Makine her sabah içinde 350 adet kola ile güne başlıyor;
- Sabah dokuzdan önce ve akşam beşten sonra hiç kola satışı yapılmıyor;
- Gün boyunca ortalama her saat 50 adet kola satılıyor.Yalnız saat 10 ile 11 arsında ve öğle yemeği vakti olan 13 ile 14 saatleri arası bu satış diğer saatlerin üç katına çıkıyor.
- Makineye öğle yemeği vakti gelmeden önce 12 ile 13 saatleri arasında hiç satış yapılmıyor ve 300 adet kola ilave ediliyor.

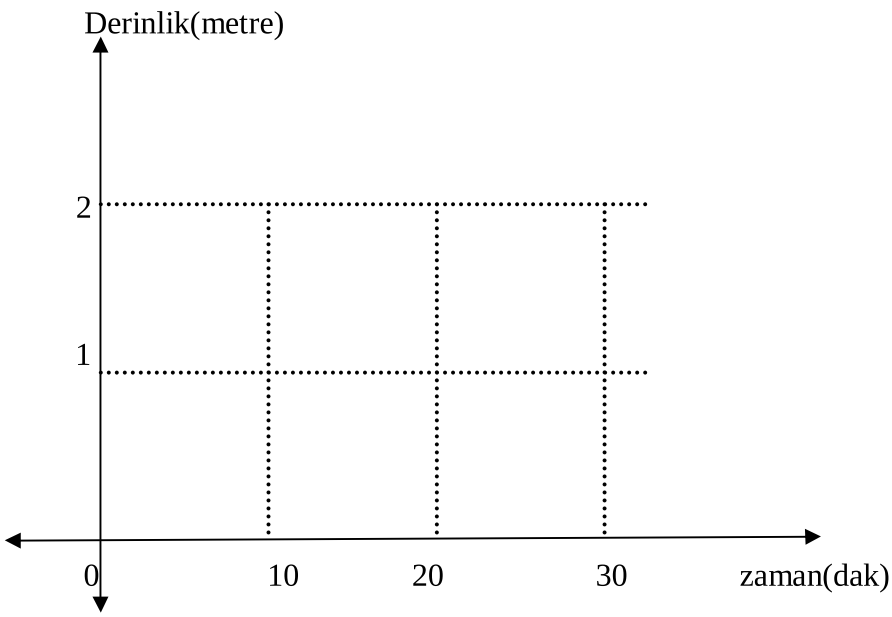
Yukarıda verilen şartlara uyarak makinedeki kola sayısının sabah 8 ile akşam 18 arasındaki dağılımının grafiğini çiziniz.



12)



Yukarıda boş bir havuzu dolduran bir musluk vardır. Musluk açıldıktan sonra havuzun tamamı yarım saatte dolmaktadır. Buna göre havuzun derinliğinin(içindeki suyun yüksekliğinin) zamana göre değişim grafiğini çiziniz.



APPENDIX B

ACTIVITY SHEETS ON FUNCTION

Konya Endüstri Meslek Lisesi Tanıtım Bilgiler

KONYA ENDÜSTRİ MESLEK LİSESİ

BİLGİSAYAR KOLU

OTOMOTİV KOLU

KÜTÜPHANECİLİK KOLU

GAZETECİLİK KOLU

- ✓ *ÖĞRETİM SÜRESİ 3 YIL*
- ✓ *İKİ DÖNEM STAJ*

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BİLGİSAYAR ŞİRKETLERİ

- CASPER BİLGİSAYARCILIK
- HP BİLGİSAYARCILIK
- VESTEL LİMİTED ŞİRKETİ

OTOMOTİV ŞİRKETLERİ

- HONDA
- RENAULT
- TOFAŞ

KÜTÜPHANELER

- HALK KÜTÜPHANESİ
- MİLLİ KÜTÜPHANE
- ÜNİVERSİTE KÜTÜPHANESİ

GAZETELER

- AKŞAM GAZETESİ
- HÜRRİYET GAZETESİ
- MİLLİYET GAZETESİ
- SABAH GAZETESİ
- STAR GAZETESİ
- VATAN GAZETESİ

BİLGİSAYAR KOLU

- İKİ DEFA STAJ YAPIYORLAR

- İLK STAJLARINDA TOPLU HALDE HAREKET EDİYORLAR

- İKİNCİ STAJLARINDA BİLGİSAYAR KOLUNA AİT ÖĞRENCİLER KENDİ BRANŞLARINDA,İDARENİN BELİRLEDİĞİ ŞİRKETLERİN HERHANGİ BİRİNE STAJ YAPABİLİRLER

- EN AZ ÜÇ ÖĞRENCİSİ VAR

KÜTÜPHANECİLİK KOLU

- İKİ DEFA STAJ YAPIYORLAR

- “BİRLİKTEN KUVVET DOĞAR” FELSEFESİNİ BENİMSİYORLAR.

- BİRBİRLERİNİ O KADAR ÇOK SEVİYORLAR Kİ İKİNCİ STAJLARINDA DA AYRILMIYORLAR. İDARE SADECE BU KOLA ÖZEL OLARAK İSTEKLERİNİ KABUL EDİYOR.

GAZETECİLİK KOLU

- İKİ DEFA STAJ YAPIYORLAR
- İLK SENEKİ STAJLARINI HEPSİ AYNI YERDE YAPIYORLAR
- STAJ YERİ SAYISI KADAR SAYIDA ÖĞRENCİ ALINIYOR
- İKİNCİ STAJLARINI İSE HERKEZ FARKLI GAZETELERDE YAPIYOR.

HÜRRİYET VATAN AKŞAM

MİLLİYET SABAH STAR

OTOMOTİV KOLU

- İKİ STAJ YAPIYORLAR
- İLK STAJLARINDA "BİRİMİZ HEPİMİZ İÇİN, HEPİMİZ BİRİMİZ İÇİN" FELSEFESİNİ SAVUNUYORLAR.
- İKİNCİ STAJLARINDA İDAREYİ DİNLEMEK ZORUNDALAR.
- ŞİRKETLER STAJER ÖĞRENCİLERİ FARKLI ALANLARDA ÇALIŞTIRABİLİYORLAR.

HONDA: DÜNYANIN EN İYİ MOTORLARINI ÜRETİYORUZ. STAJERLERİMİZİ BURADA DENEYİM KAZANIR.

RENAULT: OTOMOTİVDE EN ÖNEMLİ BÖLÜM SERVİSTİR. SATIŞ SONRASI İYİ HİZMET VEREN ŞİRKETLER DAİMA POPÜLER OLMUŞLARDIR.

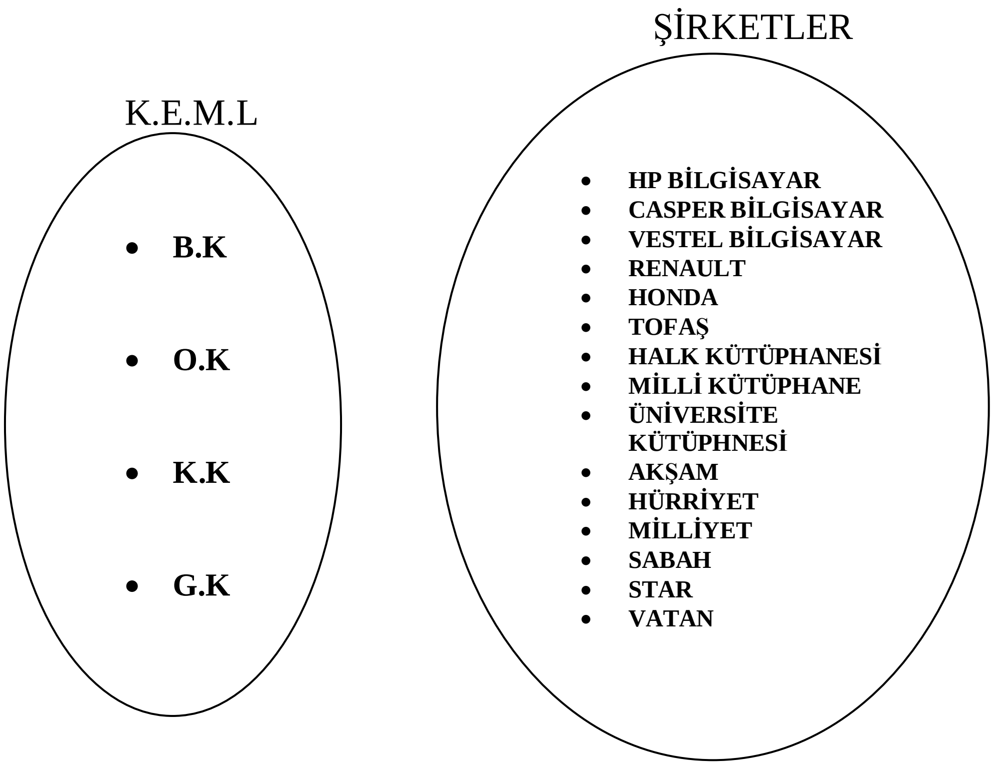
TOFAŞ: İTALYAN ASILLI TASARIMCILARIMIZIN GÖZETİMİNDE MÜTHİŞ TASARIMCILAR YETİŞTİRİYORUZ.

İDARE

- ✓ MEZUN OLMASI İÇİN HER KOLUN İKİ DEFA STAJ YAPMASI GEREKLİ,
- ✓ HER KOLUN KENDİ ALANINDA STAJ YAPMASI GEREKLİ,
- ✓ KOLLAR İLK STAJLARINDA ORTAK HAREKET ETMEK ZORUNDALAR,
- ✓ KÜTÜPHANECİLİK KOLU HARİÇ; DİĞER KOLLAR İKİNCİ STAJ DÖNEMİNDE,KENDİ ALANLARIYLA İLGİLİ ŞİRKETLERE EN AZBİR ÖĞRENCİ GÖNDERMEK ZORUDA,
- ✓ LİSTEDEKİ YERLERDEN BAŞKA YERLERDE YAPILAN STAJLAR KABUL EDİLMİYOR.

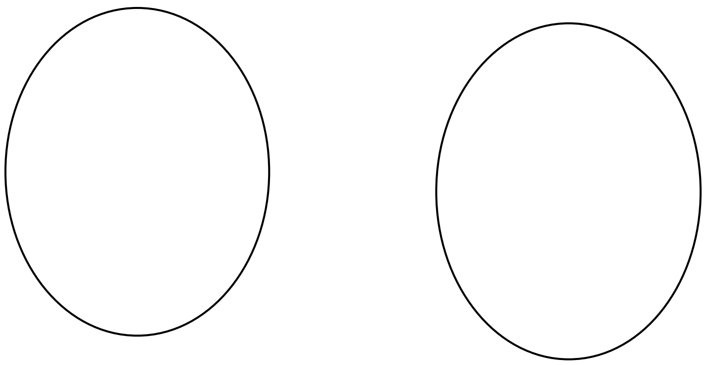
FONKSİYON TANIMI

Konya endüstri meslek lisesinde(KEML) bulunan dört tane önemli kol vardır(1). Her bir kola mezuniyet belgesi vermek için derslerdeki başarının yanı sıra, iki defada staj yapmak zorunda.Bu dört kol; Bilgisayar kolu(B.K),otomotiv kolu(O.K), kütüphanecilik kolu(K.K) ve gazetecilik koludur(G.K) (1). İdarenin emriyle her kola ait öğrenciler ilk stajlarında ortak hareket etmek zorundadırlar(7). Her kolda kendi alnıyla ilgili şirketler seçmek zorunda. Bilgisayar kolundakiler bilgisayar şirketleri, otomotiv kolundakilerin otomotiv fabrikasında çalışması gibi(2).



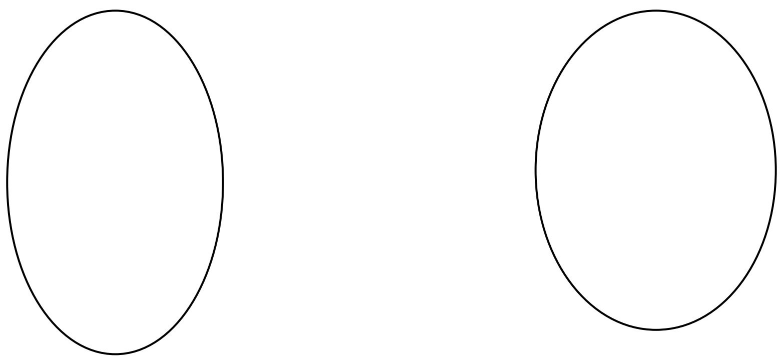
1-1 (BİREBİR) FOKSİYON

Bilgisayar kolu , otomotiv kolu, gazetecilik kolu ve kütüphanecilik kolu grup olarak farklı şirketlerde staj yaptıklarını göz önünde tutarak fonksiyonun 1-1 olduğunu söyleyebiliriz.



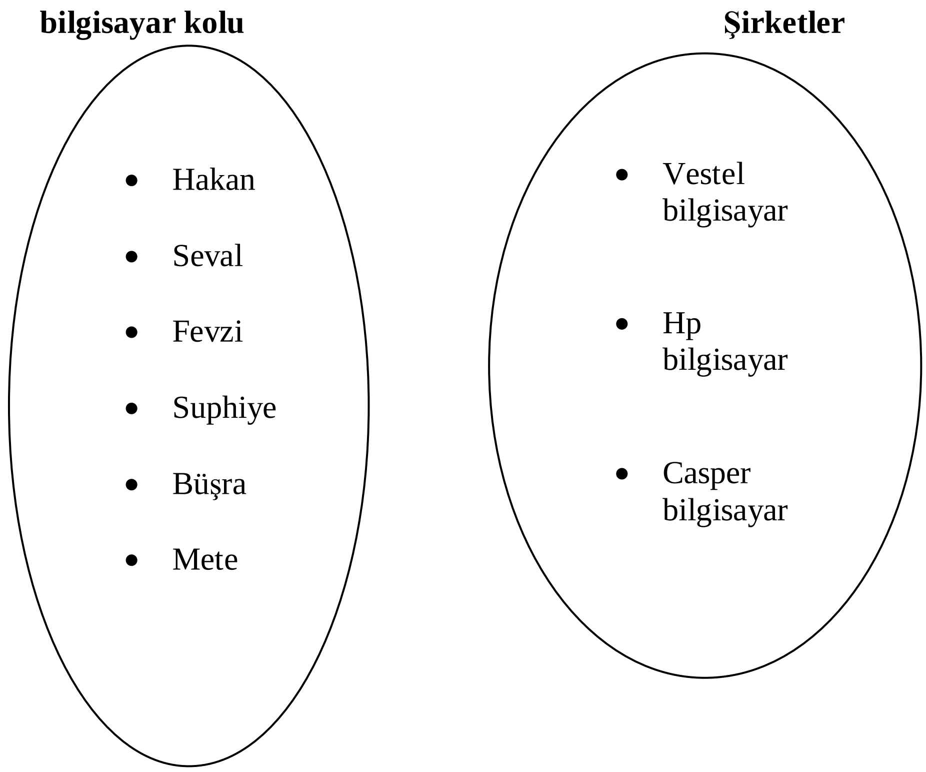
İÇİNE FONKSİYON

Bilgisayar kolu,otomotiv kolu, gazetecilik kolu, ve kütüphanecilik kolu grupları farklı yerlerde staj yaptıkları ve şirketler kümesinde ki bazı şirketlere giden kol olmadığı için içine fonksiyon olarak da tanımlayabiliriz.



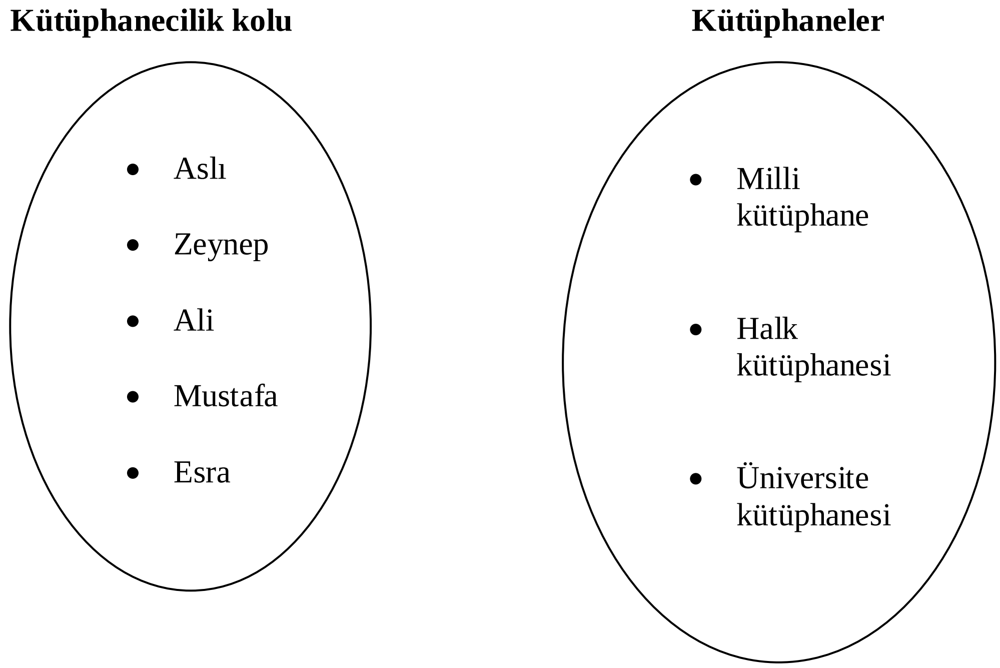
ÖRTEN FONKSİYON

Bilgisayar kolu öğrencileri ikinci sınıf stajlarını yaparken, ilk stajda olduğu gibi toplu hareket etmek zorunda değiller(3) . Hatta bunun aksine idarenin aldığı bir karara göre, şirketlerin her birine en az bir öğrenci gitmek zorunda.



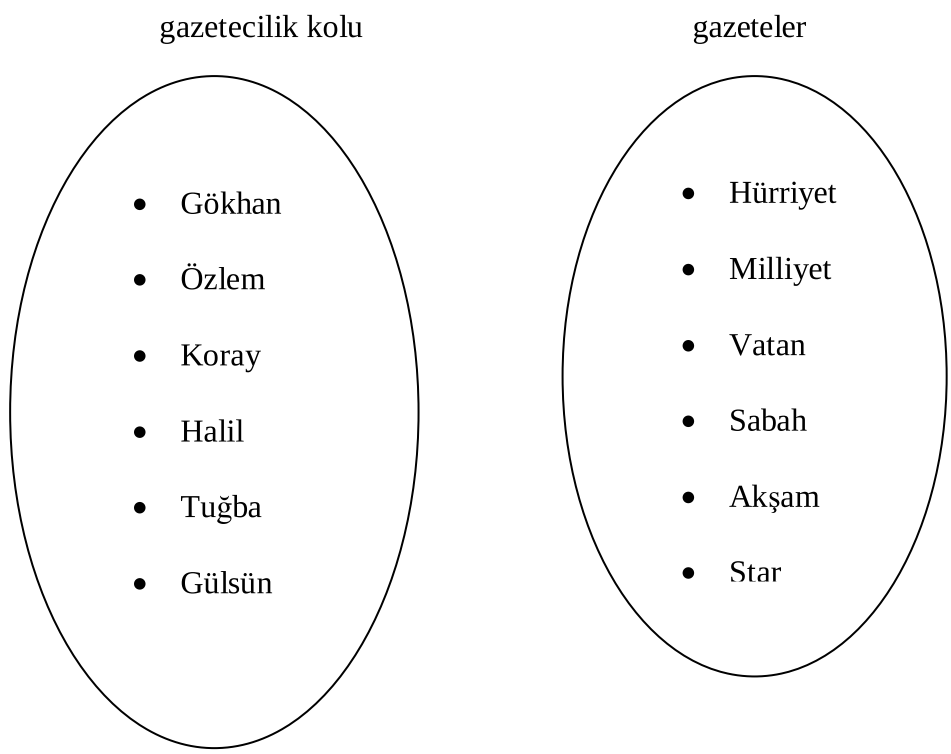
SABİT FONKSİYON

Kütüphanecilik kolu hariç diğer bütün kollar ikinci stajlarını farklı şirketlerde yapma zorunlulukları var iken bu koşul kütüphanecilik koluna getirilmemiştir.(7) Birbirini çok seven ve sıkı arkadaşlık ilişkileri olan kol üyeleri de ikinci staj dönemi için anlaşarak tek bir kütüphaneye gitmişlerdir.(4)



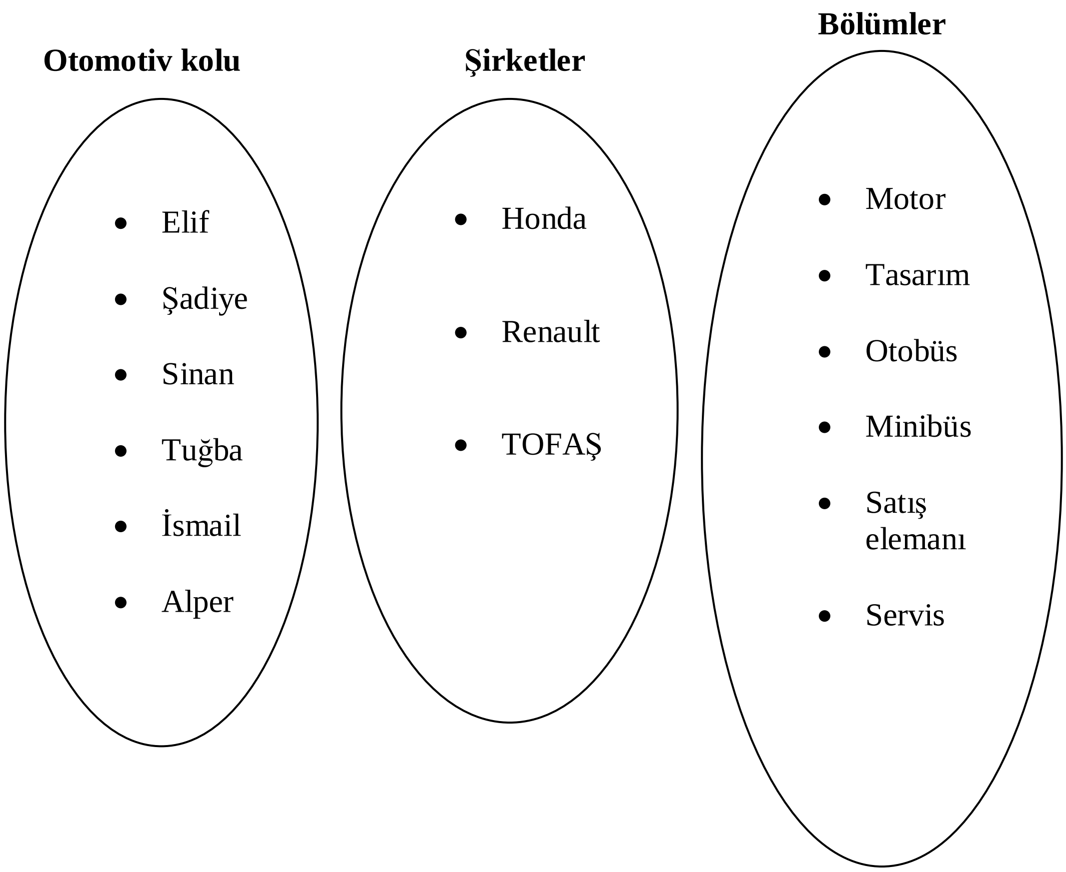
TERS FONKSİYON

Gazetecilik kolu öğrencileri de,otomotiv ve bilgisayar kolunda olduğu gibi ikinci stajlarında farklı gazetelere gitmek zorunda kalıyorlar. Yalnız gazetecilik kolundaki öğrencilerin sayısı, staja gidilecek gazete sayısıyla sınırlı.Her öğrenciye bir gazete düşmesi için altı gazete olduğundan kola sadece altı öğrenci alınıyor.Her öğrenciye bir gazete veya bunun <u>tersi olarak her gazeteye bir öğrenci karşılık geliyor.</u>



BİLEŞKE FONKSİYON

Otomotiv kolu da,bilgisayar ve gazetecilik kolunda olduğu gibi ikinci stajlarında idarenin onayladığı farklı şirketlerde çalışabiliyorlar(6). Fakat idarenin şartlarından olan kendi alanlarıyla ilgili her staj yerine en az bir öğrencini gitmesi koşuluna dikkat etmek zorundalar(7).Bu şirketler (Honda,Renault ve Tofaş) de öğrencileri şirketin kendi isteğine göre farklı bölümlerde çalıştırabiliyorlar.



APPENDIX C

MATHEMATICS ATTITUDE SCALE

13. Yıllarca matematik okusam bıkmam. O O O O O

Adınız Soyadınız:………………………………………….. Cinsiyetiniz:…………..
Okulunuzun İsmi:………………………………………. Sınıfınız:………………

MATEMATİK DERSİNE KARŞI TUTUM ÖLÇEĞİ

Genel Açıklama: Aşağıda öğrencilerin matematik dersine ilişkin tutum cümleleri ile her cümlenin karşısında "Tamamen Uygundur", "Uygundur", "Kararsızım", "Uygun Değildir" ve "Hiç Uygun Değildir" olmak üzere beş seçenek verilmiştir. Lütfen cümleleri dikkatli okuduktan sonra her cümle için kendinize uygun olan seçeneklerden birini işaretleyiniz.

	Tamamen Uygundur	Uygundur	Kararsızım	Uygun Değildir	Hiç Uygun Değildir
1. Matematik sevdiğim bir derstir.	O	O	O	O	O
2. Matematik dersine girerken büyük sıkıntı duyarım.	O	O	O	O	O
3. Matematik dersi olmasa öğrencilik hayatı daha zevkli olur.	O	O	O	O	O
4. Arkadaşlarımla matematik tartışmaktan zevk alırım.	O	O	O	O	O
5. Matematiğe ayrılan ders saatlerinin fazla olmasını dilerim.	O	O	O	O	O
6. Matematik dersi çalışırken canım sıkılır.	O	O	O	O	O
7. Matematik dersi benim için angaryadır.	O	O	O	O	O
8. Matematikten hoşlanırım.	O	O	O	O	O
9. Matematik dersinde zaman geçmez.	O	O	O	O	O
10. Matematik dersi sınavından çekinirim.	O	O	O	O	O
11. Matematik benim için ilgi çekicidir.	O	O	O	O	O
12. Matematik bütün dersler içinde en korktuğum derstir.	O	O	O	O	O

14. Diğer derslere göre matematiği daha çok severek çalışırım.	O	O	O	O	O
15. Matematik beni huzursuz eder.	O	O	O	O	O
16. Matematik beni ürkütür.	O	O	O	O	O
17. Matematik dersi eğlenceli bir derstir.	O	O	O	O	O
18. Matematik dersinde neşe duyarım.	O	O	O	O	O
19. Derslerin içinde en sevimsizi matematiktir.	O	O	O	O	O
20. Çalışma zamanımın çoğunu matematiğe ayırmak isterim.	O	O	O	O	O

APPENDIX D

ANSWER KEY

1) $A=\{-2,-1,0\}$

$f(x)=x^2-3x$

$\left.\begin{aligned} f(-2)&=10\\ f(1)&=4\\ f(0)&=0 \end{aligned}\right\}$ ……………………………………………2 marks

$f(A)=\{10,4,0\}$ ………………………………………..1 mark

Totally 3 marks

---

2) $f(-3)=1$ ………………………………………………1 mark

$f(1)=0$ ………………………………………………..1 mark

$f^{-1}(2)=0$ ……………………………………………...1 mark

$f(-3)+f(0)+f^{-1}(2)=1+0+0=1$ …………………1 mark

Totally 4 marks

---

3) $x\neq 0 \Rightarrow x\neq -4$ …………………………………………..... 1 mark

$x=\dfrac{y-3}{x+4}\Rightarrow xy+4x=y-3\Rightarrow xy-y=-4x\Rightarrow y=\dfrac{-4x-3}{x-1}$ ….2 marks

$x\neq 1$ …………………………………………………………..1 mark

$f:R-\{4\}\rightarrow R-\{1\}$ ……………………………………….1 mark

$\left.\begin{aligned} a&=-4\\ b&=1\\ a-b&=-5 \end{aligned}\right\}$ …………………………………………………1 mark

Totally 6 marks

4) $\frac{3}{9}=\frac{a}{-6}$ ....2 marks

$-18=9a$ ....1 mark

$a=-2$ ....1 mark

Totally 4 marks

---

5) $fog(x)=f(g(x))=f(bx+2)=3(bx+2)+a=3bx+6+a$ ....2 marks

$I(x)=x$ ....1 mark

$3bx+6+a=x$ ....1 mark

$3b=1\Rightarrow b=\frac{1}{3}$ ....1 mark

$6+a=0\Rightarrow a=-6$ ....1 mark

Totally 6 marks

---

6) $(fog^{-1})^{-1}(x)=gof^{-1}(x)$ ....1 mark

$f^{-1}(2x-1)=x^2+3\Rightarrow f^{-1}(3)=7$ ....1 mark

$g(x+2)=3x+1\Rightarrow g(7)=16$ ....1 mark

$gof^{-1}(3)=g(f^{-1}(3))=g(7)=16$ ....2 mark

Totally 5 marks

---

7) If the student gave

- ✓ the definitions of function, takes…………………………2 marks
- ✓ a mathematical examples about function concept, takes…2 marks
- ✓ a concrete examples about function concept, …………....2 marks

Totally 6 marks

8) If the student gave

- ✓ the definitions of invert function, takes………..…………2 marks
- ✓ a mathematical examples about invert function, takes...…2 marks
- ✓ a concrete examples about invert function, ……………......2 marks

Totally 6 marks

---

9) If the student gave

- ✓ the definitions of component function, takes….…………2 marks
- ✓ a mathematical examples about component function,

  takes……………………………………………………...2 marks
- ✓ a concrete examples about invert function, ……………......2 marks

Totally 6 marks

---

10)

A-B The car moves between Akşehir and Konya…….………1 mark

Average speed 60 km/h…………………………………1 mark

B-C The car stops……………………………………………..1 mark

Average speed 0 km/h…………………………………..1 mark

C-D It moves through the Konya again………………………1 mark

Average speed 80 km/h…………………………………1 mark

D-E The speed of the car was changeable (maybe the car was in the Centrum)……………………………………………………1 mark

Average speed……………………………………………1 mark

E-F The car moves between Konya and Seydişehir…………...1 mark

Average speed 90 km/h…………………………………1 mark

Totally 10 marks

11) 8-9 the number of cola was constant with 350………….1 mark

9-10 the number of cola reduced from 350 to 300……....1 mark

10-11 the number of cola reduced from 300 to 150……….1 mark

11-12 the number of cola reduced from 150 to 100……….1 mark

12-13 the number of cola increase from 100 to 400……….1 mark

13-14 the number of cola reduced from 400 to 250……….1 mark

14-15 the number of cola reduced from 250 to 200……….1 mark

15-16 the number of cola reduced from 200 to 150……….1 mark

16-17 the number of cola reduced from 150 to 100……….1 mark

17-18 the number of cola was constant with 100………….1 mark

Totally 10 marks

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12) If the graph starts with a crooked…...….1 mark

$5 \le t \le 10$ ……...……………………………………………………..1 mark

If the graph starts with $(0,0)$ and ends with $(30,2)$ ....2 marks

If the second part was linear………………………………………1 mark

Totally 5 marks