



**AN EXPLORATORY STUDY TO ASSESS ANALYTICAL AND LOGICAL
THINKING SKILLS OF THE SOFTWARE PRACTITIONERS USING A
GAMIFICATION PERSPECTIVE**

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SEPTEMBER 2015

ÇANKAYA UNIVERSITY

THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

COMPUTER SCIENCE

MASTER THESIS

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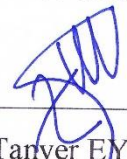
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SEPTEMBER 2015

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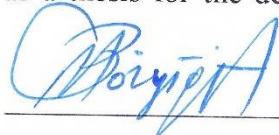
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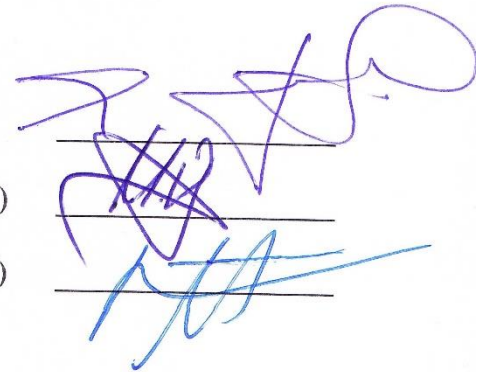
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ABSTRACT

AN EXPLORATORY STUDY TO ASSESS ANALYTICAL AND LOGICAL THINKING SKILLS OF THE SOFTWARE PRACTITIONERS USING A GAMIFICATION PERSPECTIVE

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September 2015, 71 pages

The link between analytical and logical thinking skills and success of software practitioners attracted an increasing attention in the last decade. Several studies report that the ability to think logically is a requirement for improving software development skills, which exhibits a strong reasoning. Additionally, analytical thinking is a vital part of software development for example while dividing a task into elemental parts with respect to basic rules and principles. Using the basic essence of gamification, this study proposes a mobile testing platform for assessing analytical and logical thinking skills of software practitioners as well as computer engineering students. The assessment questions were taken from the literature and transformed into a gamified tool based on the software requirements. A focus group study was conducted to capture the requirements. Using the Delphi method, these requirements were discussed by a group of experts to reach a multidisciplinary understanding where a level of moderate agreement has been achieved. In light of these, an assessment tool was developed, which was tested on both software practitioners from the industry and senior computer engineering students. Preliminary results suggest that individuals who exhibit skills in

analytical and logical thinking are also more inclined to be successful in software development.

GCCRIIS

Keywords: Gamification, Learning, Focus Group, Delphi Study, Analytical Thinking Ability, Logical Thinking Ability.

ÖZ

YAZILIM UYGULAYICILARININ ANALİTİK VE MANTIKSAL DÜŞÜNME BECERİLERİNİ DEĞERLENDİRMEK İÇİN OYUNLAŞTIRMA YÖNTEMLERİ KULLANIMI ÜZERİNE EKSPLOLATİF BİR ÇALIŞMA

KAYALI, Şahin

Yüksek Lisans, Bilgisayar Mühendisliği Anabilim Dalı

Tez Yöneticisi: Yrd. Doç. Dr. Murat YILMAZ

Eylül 2015, 71 sayfa,

Analitik ve mantıksal düşünme becerileri ile yazılım geliştiricilerin başarısı arasındaki bağlantı son on yıl içinde artan bir ilgiye konu olmaktadır. Birçok çalışma kuvvetli bir akıl yürütme isteyen yazılım geliştirme becerilerinin artmasında mantıksal düşünme yeteneğinin bir gereklilik olduğunu göstermektedir. İlâveten, analitik düşünme, yazılım geliştirme süreçlerinin hayati bir parçasıdır. Örnek olarak, temel kural ve ilkelere uyararak bir konuyu yapı taşlarına ayırmak gösterilebilir. Oyunlaştırmanın temel özünü kullanan bu çalışma bilgisayar mühendisliği öğrencileri gibi yazılım uygulayıcılarının analitik ve mantıksal düşünme becerilerini değerlendirmede bir mobil sınav platformu önermektedir. Değerlendirme soruları literatürden alınarak yazılım gereksinimlerine dayanan oyunlaştırılmış bir araca dönüştürülmüştür. Gereksinimleri belirlemek için odak grup çalışması yapılmıştır. Bu gereksinimler çok disiplinli bir anlayış kazanmak için bir grup uzman tarafından Delphi metodu kullanılarak ele alınmıştır. Bunlar ışığında, hem yazılım uygulayıcıları hem de son sınıflardaki bilgisayar mühendisliği öğrencileri üzerinde test edilmiş bir değerlendirme aracı geliştirilmiştir. Öncül sonuçlar göstermektedir ki, analitik ve mantıksal düşünme becerileri gösteren bireyler aynı zamanda yazılım geliştirmede başarılı olmaya yatkındırlar.

Anahtar Kelimeler: Oyunlaştırma, Mobil Öğrenme, Odak Grup, Delphi Çalışması, Analitik Düşünme Yeteneği, Mantıksal Düşünme Yeteneği.

ACKNOWLEDGMENTS

I would like to thank my thesis advisor Assist. Prof. Dr. Murat YILMAZ for patiently supporting me during my research and studies for the present thesis. I would also like to sincerely thank him for his guidance, encouragement and generous comments during my studies.

I extend my sincere thanks to my mother Vilma KAYALI, my grandfather Mehmet Şeref KAYALI, my sister Fatmanur AKBABA and my sister's husband Doğu AKBABA for not having left me alone for years, being with me under any circumstances and always supporting me.

I am very grateful to my dear friend Mehmet Serkan AYKUT for supporting me on developing the mobile application that I prepared in scope of my thesis study and answering patiently any questions he was asked.

Foremost, i would like to express my deepest thanks to Ecem KELEŞOĞLU who has never left my hand through good and bad times. She never stopped supporting and loving me and believing in that I was to complete the present study. She helped me a lot to overcome the most stressful moments and settled me. I could have been unable to complete this study without her.

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LIST OF ABBREVIATIONS

CAI	Computer Aided Instruction
SOHAT	The Scale of Holistic and Analytical Thinking
TOLT	Test of Logical Thinking
GALT	Group Test of Logical Thinking
QA	Quest Atlantis
JSP	Java Server Pages

CHAPTER 1

INTRODUCTION

We now live in a world where new technologies are frequently introduced. To be successful in this competitive environment an individual must be able to improve his or her cognitive skills every day. And in such a world, knowledge workers need to utilize the collected knowledge and use it to develop better skills in an effective way. However, improving personal and professional success depends on lifelong learning and continuous self-improvement [1]. In particular, students of this new area should understand the relationship between their analytical and logical thinking skills and their future success.

Jacobsen et al. [2] suggested that there is a positive relationship between sensory and cognitive attributes of individuals, and ultimately the success level of students is directly proportional to such skill sets. In a study conducted in 17 countries, Bloom [3] also argued that the cognitive attributes of an individual are directly proportional to his academic success.

The thinking abilities of individuals were accepted as a skill and different definitions were made. Lipman [4] stated that thinking skills vary from person to person since they are personal skills. He also argued that differences could arise in comprehension and discernment as logical thinking skills differ based on individuals.

Improvement of individuals' logical and analytical thinking skills has become important because it affects the success of individuals in the field of software engineering. The basis of logical thinking is the sequential thinking process. The continuation of the process requires the ideas, findings and the results related to

problems to be determined and the data obtained to be regulated. The success of reaching the goals and dealing with the difficulties of the complex world depends on the logical thinking skills of the individuals [5]. One of the subjects put excessive emphasis on in education is logical thinking ability and it is indicated that it has a great effect on student's success [6].

Sternberg and Grigorenko [7] divided thinking skills into 3 categories: analytical, creative and practical thinking. Analytical thinking involves the processes of knowledge-based problem solving and decision-making. According to a definition provided by Ruskin [8], being analytical is "breaking things, situations, practices, problems, statements, ideas, theories, arguments down into their component parts." [8, pp. 1], Mathematics is the foundation of analytical thinking. Chuah [9] claims that students who study at the department of engineering sciences must have analytical and logical thinking abilities so that they can make rational decisions on the foundations of engineering.

Fatin [10] states that the importance of analytical thinking in engineering education where students are expected to make an inference when comparing and reason when taking risks and making decisions. Robbins [11] claims that analytical thinking skill is necessary when solving out the facts and both analytical and logical thinking skills are necessary when solving problems.

How we see education has taken a new form through the ideas related to the development of analytical and logical thinking skills. By benefiting from the opportunities of technology, an aim is to improve the motivation of individuals. Through the computer and the Internet usage, a new generation growing up with digital games and defined as G-generation¹ has appeared [12]. We cannot set apart this generation of today, which is called information age, from computer and the technology, which comes along with it. People of this generation are continuously using the Internet and connected with the social networks. They use game elements and gaming principles during these activities constantly without even realizing it. The

¹Children who were born after 2000

research shows that this generation plays games for more than 10.000 hours a day in average [13]. Prensky [14] describes this new generation who was born and is growing up with the technology age as “*digital natives*”. Students now learn by playing willfully and fondly in an environment that computer technology provides for them [15].

One of the most important concepts for using technology in education is called Computer Aided Instruction (CAI). The quality of software designed in CAI largely affects teaching. While well-developed software can have positive effects on individuals’ success, badly developed software can have negative effects on individuals.

To this end, educational games usage improves day by day and researches are done on this topic. Dominguez et al. [16] aimed at using the video games by transferring the good sides of them into environments where there is no game, instead of using them to train individuals.

Zickerman and Cunningham [17] define the gamification as “*the usage of thinking style in the game and the game rules to draw the users*” attention and solve problems. Deterding et al [18] use the term gamification to refer to the usage of game design in contexts in which there is no game. In this regard, the design must be clear first so that gamification could be implemented. And if this design could be used in contexts or environments, where no game exists, gamification process is completed.

In this context, the game design to be carried out is very important. Bunchball [19] put in order the outlines of gamification components as points, badges, levels, experience and leaderboards. Points can be described as a prize given as a result of success achieved during the game. Badges are prizes given for the general success in the game. For instance, individuals who achieve different successes are also given rating badges. The games using the gamification components effectively reached a big target audience.

Hou [20] suggests that games such as Farmville are played in order to have fun, relax and steer away from stress in daily life. Games, which are not designed to enjoy, first are called serious games. Topics such as education, trade, health, and social awareness are within the serious games. Bogost [21] discussed the existence of persuasive games. He claimed that games, which have a high level of persuasive ability, are video games and video games are games, which can change the structure of sociocultural systems and provide social change.

Gamification is a different term from serious and persuasive games. While game components are used in non-game environments in gamification, while there is a complete game platform in serious and persuasive games. This is a key difference between game and the term gamification. Hence, their areas of usage are different. Especially, in recent years, gamification has started to be used in the fields of software development and game-based learning. The typical examples of these are:

- **Foursquare:** This is a local search application in which users check into a place to gather virtual scores and prizes through GPS of mobile devices. It has approximately 75 million users today. It uses especially badges and leaderboard as gamification components.
- **Nike+:** Through an application on gamification platform, it enables athletes with wristbands to follow their daily trainings and the calories they burned. It also helps them to share these in the life coach site and it improves their motivations.
- **eBay:** By using scoring system and badges as gamification component, it provides the sellers with grading and this raises the reliability of the seller and the quality of the store.

These applications using gamification platforms try to make daily routines more enjoyable. When you look at many services or products apart from these critically, you can easily see the traces of gamification principles.

Today smartphones and tablets not only keep up with desktop computers but they also have many benefits [22]. The usage of education and productivity activities through smartphones, which G-generation prefers to carry them, improves in addition to portability, ease of use and ergonomics every day. In this study, gamification components will be presented to the users over mobile application because of all of these eases of handling.

This study seeks to address the following two questions, which should concern computer engineering students and software practitioners:

- 1- Do they have substantial skills to study computer engineering?
- 2- What is the potential success that they could achieve as a software engineer when they graduate?

In order to find answers these questions, we conduct a test study. However, many young people do not really like to use paper and pencil in this technology age. On the other hand, they insist on not taking these kinds of tests, but on the other hand they love to fill out questionnaires/surveys on the Internet to pass time.

Author believes that measuring logical and analytical thinking skills of individuals can be considered important in terms of finding answers to these questions. To this end, a mobile application is designed with the help of a set of game elements so that these questions could reach more people to be solved. Here, an aim is to improve the motivation and enthusiasm of the participants.

At first, the proposed approach is tested on people who've gained experience as software development in business landscapes. Based on the acquired results from practitioners, a threshold value is formed which will be taken as a reference for evaluating the results of the students who use the application later. Thus, the students will obtain information about which positions they can reach when they graduate. They will know how to choose the right department thanks to this design that could be applied to students of computer engineering in addition to university applicants.

To determine the design framework to be prepared, experts will be consulted through a Delphi study. This way, a design, which is fit for purpose, will be prepared in the most correct way. At the end of the design, individuals will get feedbacks, which are suitable for the gamification platform, and their motivation will increase.

The general structure of the study consists of six parts including the introduction. The configuration of the thesis is as follows:

Chapter 2: This chapter consists of a literature review which explains how logical and analytical thinking abilities are used in the fields of engineering and education, how gamification components can be integrated into these fields as well as examples of how these components were integrated into mobile devices.

Chapter 3: This chapter briefly describes the research methods and how these methods are used. It explains how qualitative and quantitative research types were used during the study, focus group and Delphi study processes and the framework obtained as a result of the study.

Chapter 4: In this chapter, the definition of the system and the details are given. The tools used in designing the software and the uses of them are explained. Additionally, the features of the web and mobile interfaces and their utilization are described.

Chapter 5: In this chapter, the results of the assessments obtained from the participants are analyzed, and the analysis of the results of the study is provided.

Chapter 6: This chapter includes a brief summary of the whole study. Furthermore, it involves a detailed interpretation of the results obtained during the study. It concludes with some ideas for future work.

CHAPTER 2

BACKGROUND AND RELATED WORKS

2.1 Introduction

This chapter starts with the definition of analytical and logical thinking skills and explains its use in the literature. Next, it details the term gamification and game-based learning and discusses the advantages of applications in the fields of education and engineering. Furthermore, it mentions mobile assessments and its advantages over traditional approaches. Finally, a brief summary is presented to conclude this chapter.

2.2 The Ability to Think Analytically and Logically

Analytical thinking can be described as induction² [23]. Therefore, individuals who have the ability to think analytically allocate the category of the problem during the examination. Dewey [23] suggest that people who have developed the ability to think analytically complete the system by examining the components first, in opposition to those with holistic thinking by considering the object as a whole at first glance. Holistic thinking can be described as deduction [24]. Dewey [23] claims that people who have the holistic thinking ability choose to evaluate the object as a whole at first glance than evaluating it through its components.

²Reaching general judgments based upon individual facts that are observed

Umay and Ariol [25] developed “The Scale of holistic and analytical thinking” (SOHAT) to specify the level of students’ analytical thinking ability (see Appendix B, Chapter I). Taking into account the features of holistic and analytical thinking styles, 5 items that were thought to express the reflections on problem solving performance of these styles were developed for SOHAT. 18 people were consulted as specialist opinion for the validity studies of the developed scale. The reliability coefficient of the scale was calculated as 0.78.

Karplus [26] mentions the definition of logical thinking, which is solving the individuals’ problems by using mental ability. Temizyürek [27] claims that it is important for individuals, who are curious, have creative thinking and are productive to be educated in terms of revealing the unknown facts in sciences.

Soylu [28] emphasizes that the logical thinking is not only an activity that includes cognitive process, but also a way of thinking which functions by the rules and involves the testing process of current situations and evaluates and develops current situations.

Tobin and Capie [29] developed the Logical Thinking Test (TOLT), which consist of ten items (see Appendix B, chapter II). These are used to measure 5 reasoning forms: controlling variables, combinatorial reasoning, probabilistic reasoning, correlational reasoning and proportional reasoning. Analysis of the data revealed a high level of test validity and reliability (coefficient $\alpha = .85$) Roadranga et al. [94] also developed a (GALT) group test of logical thinking [6, 7, 15]. Both of the test results are the same but the methods that they used are different.

From past to present, different ideas related to the ability to think analytically and logically have been put forward and researches have been done within the frame of these ideas. Through various studies, it has been observed that especially individuals who received education on sciences and engineering have a high ability of analytical thinking [3, 11] and logical thinking skills [5, 7, 8, 17].

2.2.1 Sample Study about Test of Logical Thinking and the Scale of Holistic and Analytical Thinking

Sebetçi and Aksu [30] conducted an empirical study in which 142 students were tested to identify the level of analytical thinking. SOHAT was exercised and in order to determine the level of their logical thinking ability, TOLT was conducted. The pass marks that the students got from the courses were used in order to compare the results obtained from these tests. In addition, the students were tested to measure the differences between one another in terms of their socio demographic characteristics. It was found that analytical thinking was meaningfully associated to the marks that students got from the programming courses. In addition, logical thinking was meaningfully associated to the marks that students got from the programming courses. In light of these results, when the ability to think analytically and logically develops, their success of programming will also improve. Thus, techniques and methods are recommended to promote students to think analytically and logically.

Wong et al. [31] carried out a study through TOLT with 501 test papers being completed successfully. The results showed that the logical thinking ability of the people tested was poor and their induction ability was better than their deduction ability. The practices of logical thinking affected the deduction ability of the tested people.

Kılıç and Sağlam [32] tested 586 students at secondary education. In the study, it was examined whether the students' logical thinking ability was influenced or not by factors of sexuality, age and school type. To identify the logical thinking ability of the students, TOLT was exercised and to analyze the gathered data, one-way analysis of variance was exercised. The findings of the study confirmed that the ability of logical thinking had a meaningful difference depending on sexuality and school type. [32] In addition, the age variable did not have an effect on the students' logical thinking ability.

Geban et al. [33] conducted a study using the TOLT where 200 students got involved, 2 teachers were selected and given to different groups randomly. Consequently, it was

found that problem solving through computer simulation was more successful than the traditional systems.

Tezcan and Bilgin [34] performed a study after the students grasped the topic solubility, aimed to compare the effects of laboratory-aided teaching system with the effects of conventional techniques and to determine whether prior knowledge and the ability of logical thinking, the sexuality and the economic situation had an impact on understanding of the subject or not. There were 2 groups as control group and experimental group. In the control group, the subject was treated using conventional techniques and in the experimental group, it was treated using laboratory-aided teaching system. Before training, TOLT was applied to the students. The results were evaluated with t-test and Ancova (Analysis of Covariance). It was found that sexuality and the economic situation did not have an impact on students' comprehension and that the marks of TOLT did not have a strong effect on the success in teaching as expected. Additionally, the results were not statistically significant. This is because the students were not accustomed to reason in learning.

Mattheis et al. [35] conducted a study to determine the students' discernment, where they tested the students' logical thinking ability and their integrated practice skills. In the study, they also examined the students' participation in out-of-school activities and the teachers' past performance changes. The results of the study revealed that the logical thinking ability of the students and some other characteristics were similar to 2 countries where a comparison was made.

Ünal et al. [36] explored the impacts of students' logical thinking skills and the teaching method used on conceptual understanding of some science concepts. Achievement Test, TOLT and Concept Test were given to 87 students. The students were divided into 2 groups and the study continued for 5 weeks. The results of the TOLT showed that the students' logical thinking ability made a contribution to their conceptual understanding of science concepts.

Yenilmez et al. [37] measured the ability to think logically and the achievement through the TOLT and 2-tier test respectively. Ancova, one of the statistical research

methods, was used to measure the effect of logical thinking on student's success. Independent variable was logical thinking and dependent variable was the scores in 2-tier. According to the statistical analysis, a significant difference was observed between the high marks and low marks of the students from the TOLT.

Heppner et al. [38] conducted a research for examining the differences between the students who consider themselves as successful and the ones who consider themselves as unsuccessful at problem solving. As a result, it was observed that those who consider themselves as successful think that they are more motivated for problem solving, more successful and believe their abilities and their efforts play an important role in problem solving, are more consistent, systematic and behave less reactively, see the problems as a part of their lives and they don't avoid looking for solutions and they learn from others most of time, are more determined, careful, intuitive, more secure about interpersonal intuition and make more environmental changes in opposition of others.

Umay and Ariol [25] examined the effects of analytical and logical thinking styles on the performance of solving math problems and the selected ways to solve them. In order to identify the holistic and analytical thinking styles, the Scale of Holistic and Analytical Thinking Styles While Problem Solving (SOHAT) was applied and in order to specify the performance of problem solving, the Paper of Problem Solving was applied to 189 students. Based upon the results, no significant distinction was observed between the participants who had holistic thinking styles and the ones who had analytical thinking styles in terms of their performance of problem solving and the ways they used to solve problems.

Yenilmez et al. [39] tested 174 students using the TOLT for measuring logical thinking ability. They used two ways analysis of variance to measure the effect of sexuality and class difference on the logical thinking ability. The results showed that both class level and sexuality made a significant contribution on the logical thinking ability.

Wilborn [40] carried out a study in order to enhance the students' problem solving skills and their interest of solving the world's problems. Each of these groups was

taught problem solving strategies, questioning techniques and the teaching was supported with images, schemas and graphics. They focused on writing and reading the problems, understanding the world's problems and language development in mathematics. The results indicated that when the students learn problem solving strategies and how to read and understand the world's problems, they enjoy solving problems and they achieve success in solving the world's problems.

2.2.2 Sample Studies about Group Test of Logical Thinking

Aksu and Berberoğlu [41] studied how the ability of logical thinking differed based on sexuality, school, education levels of parents, success in school and matriculation. In this study, GALT was exercised so as to measure the problem solving ability. The research showed that when the parents' level of education advanced, their marks of the GALT would be higher and they would be associated to school success and matriculation marks and they would be high on behalf of the boys and would differ among schools.

Williams [42] measured logical thinking through the GALT. In the study, additional data was collected in order to determine the connections between logical thinking and the number of hours spent on science and mathematics studies. The data analysis showed that logical thinking skills develop between 12-15 ages continually. Sexuality differences had an impact on logical thinking skills. The relationship between logical thinking and the number of hours spent on science studies is quite important.

Kaptan and Korkmaz [43] conducted a study to explain the effects of problem-based learning approach on the pre-service teachers' levels of problem solving skills and self-efficacy beliefs. There were 102 people in the study. The data of the study consists of the data obtained from Self-Efficacy Belief Instrument and GALT. The experimental group was lectured on problem-based learning approach. The results revealed that the levels of self-efficacy belief and the levels of problem solving of the group, which used problem-based learning approach, were higher.

Steer et al. [44] tested a group of students' logical ability in the GALT. This test includes logical steps such as conservation, probability and correlation thinking. 393 people got involved in the test. 15 % of students made less progress than other students in areas conservation; probability, correlation thinking and they got lower marks in the geology course. The students who was lacking in conservation skills foresaw that the transfiguration of an object changes its mass. Students who was lacking in the probability skill had difficulty with carrying the basic mathematics to the principles, which lied behind conceptual understanding. These students wanted formulas for problems that did not require calculation. Students who was lacking in the ability of correlation thinking could not link the different layer moves with extraordinary process. These skills are necessary so as to understand many ideas requiring higher level of thinking. The students who had a good correlation thinking skill could explain the casual relationships. The findings of the study confirmed that the students' logical thinking ability was important in terms of their school success.

2.3 Game-Based Applications and Gamification

Games have been an important part of in our lives even before the computers and computer-based games were developed. In the past, games that were played using materials such as table, stone and paper, which have started to adapt to virtual environment with the development of technology. Although the target group of games was males at first, they have started to attract women and children's fancy through technological progress with the video game industry. We now live in a world where everyone has game consoles and smart phones. Almost everyone plays computer games and web-based games over social networking platforms.

Gamification is the usage of components of games in systems in which no game exists in order to increase the user's experience or to connect the user to the media [45]. This expression, which started to be mentioned in 2008, did not draw attention until 2010 [45]. On the other hand, there are several applications of game for learning purposes, which can be considered as an effective way to measure success.

Bozkurt [46] describes game-based learning as providing latent or open learning, which can be considered as one of the common ground for gamification approaches.

Examples of the use of games for measurement of success are very common in the literature (e.g. game-based [52], [56], [58] gamification [57], [61], [63]). The use of games for learning has become something habitual. Dominguez [47] stated that some researchers focus on transferring the good sides of video games in application environments where no game exists, instead of materials such as video game, slide. This is where we see the term gamification, which is not related to educational environment but can be adapted to this field.

The study by Karataş [48] examined the literature for understanding the impacts of gamification on education. The results showed that the studies mostly concentrated on the graduate students and the topic of the studies dealt with the effects of gamification on academic success. Furthermore, the focus was on motivation theory as the most often used game-component and as a present, badges and a scoring mechanism were used.

Papastergio [49] compared the traditional way of learning with a game-based learning which involves the same learning goals in learning the computer memory concept that must be learned by the course of study in computer science lessons. It has been also tested how the training differs between the sexes in terms of motivation and learning difference. While gamification has been applied to some of the students, the traditional way of learning has been exercised to the other students. Computer Memory Knowledge Test was given to every student as a pre-test and a post- test in order to measure the changes in students' knowledge about computer memory term before and after gamification. After this, the students using gamification filled in a feedback questionnaire. The results of this study showed that the male and female students using the game-based learning method were found to be more motivated and more stimulated compared with the ones using the traditional way of learning.

Engin et al. [50] conducted a study so as to research the use of computers in educational environment, the methods used and the problems encountered. The study focused on

web based training, exercise and practice, educational games, simulation software, instructional tests and one-on-one teaching programs. The study revealed that the use of games as children's favorite activity ease students' concentration and their adaption. This conclusion was supported recommending that students were at the center of the game-based learning.

In order to investigate the educational potential of electronic games, Gomes and Teixeira [51] applied a research, which consist of two sections. The first section was Massively Multiplayer Online Games where the motivation of achieving educational tasks related to development of problem solving skills and communication and interaction skills were analyzed. The second section was where the reflections of the first section on the users were observed.

Üçgül [52] researched the relation of motivation for educational computer games with sexuality and the weekly use of computer and the weekly playing time of computer games. In the study, as the educational game, TombRaider: The Last Revelation was used with 71 students. In this series of the game, the users were given chances to design new episodes and the researcher redesigned the game as science and technology game. After playing the game during a lecture, the researcher asked the students to fill in the Instructional Materials Motivation Survey to measure the motivation effect as the teaching material of the game. As a result, the sexuality, the time of weekly use of computer and the weekly playing time of computer games did not affect the students' motivation for educational computer games.

Pivec et al. [53] studied the ways of game-based learning. It has been mentioned that games for learning will ease the learning process. It provides for more users to access information and practice inside the virtual world. In this study, the game-based learning model made by Garris has been mentioned.

By developing 2 educational computer games concerning ratio and proportion in mathematics for primary education students, Çankaya and Karamete [54] studied the effects of these games on the attitudes of students towards mathematics and educational computer games. In order to identify the attitudes of students to

mathematics and the developed computer games, a likert scale was used. The developed games and the scale were exercised to 176 students. It was tested whether the developed games had a significant change on the attitudes of students towards mathematics and the educational computer games through t-test. It was tested whether a meaningful relationship existed between the attitudes of the students to mathematics and educational computer games through the correlation test. The results of this study indicated that the students had a positive attitude to mathematics and educational computer games. However, no significant change was seen between the attitudes of students playing each of the 2 developed games.

Klawe [55] focused on mathematics and computer education of students from primary education. To this end, he developed E-GEMS Project. The reason for this is that most children become disinterested in mathematics after this age range. The results indicated that the role of the teacher is very important for increasing the success in learning mathematics. The results also pointed the learning speed between girls and boys. Girls usually spent their time discovering and communicating, whereas boys improved faster.

Bayırtepe and Tüzün [56] conducted a research to investigate the effects of educational computer games on the success of primary education students' computer class and their perceptions of computer self-efficacy. To this end, a computer game concerning 'hardware' was prepared. Quest Atlantis (QA) was used for the development of the game-based learning environment. The research was conducted with the quasi-experimental design based upon the pre-test and post-test. In the study, the experiment group students learned through the game environment, whereas the group of controlled students learned through conventional ways for two weeks. Before and after the practices, the students were asked to fill in the Perceptions of Computer Self-Efficacy Questionnaire and given an achievement test. Based upon the results of the achievement test applied before and after the practices, a statistically significant increase was observed in both of the groups; however, there was not a meaningful difference between the success of learning in a game-based environment and the success of learning in an environment based upon the conventional ways and the perceptions of computer self-efficacy of the students. On the other hand, the results

revealed that the students had fun with the game-based learning environment, which reduced anxiety and helped them learn separately and visually.

Becker [57] investigated digital games and studied probabilities, thoughts and restrictions for the design of instructional games and discussed the tools used for learning in classroom as a whole. As a result, the teachers will be a gamer. If the teacher knows the games' advantages, they will teach it to children as well.

Kula and Erdem [58] have used Add'emUp, (i.e. a board game that involves games, numbers, digit and addition) which can be accessed over the Internet. The study has been carried out according to pre-test and post-test model with no control groups. A group of 46 people have been used. It has been tested whether the game has made a difference between class differences and sexualities in terms of its effects on the development of basic arithmetic operations. According to the change in the answers of pre-test and post-test before and after practices, it has been observed that the computer game used has caused a change in the operations. It is obtained that from -operations to multiple-operations, there has been a change in the answers of students in the post-test. The students have a positive attitude towards the game-based learning method because of the way it motivates and teaches the students.

In order to reveal the personalities of the software developers in software development organizations, Yilmaz and O'Connor [59] developed a personality measurement instrument using a set of game elements. It was mentioned that the proposed game-like approach brought a new perspective to the personality analysis. As a result, it was confirmed that individuals were more interested in interactive tests in social environments through various questionnaires. Additionally, a game-like application was found to have important advantages.

Tüzün et al. [60] carried out a study on the effects of teaching geography on the primary education students. The researchers designed a 3D computer game. With the aim of teaching the continents of the world and countries, the students played this game. With the quantitative and qualitative methods, the study tested the success and the motivation effect of the game on the students. According to the tests exercised

before and after the game, it is observed that the success of students increased through this game. According to this, suggestion is to use a game-based learning method in geography class.

Garris et al. [61] mentioned how to reach the desired instructional goals in their research. In teaching, games have important features. The behavior and attitudes of the instructor were studied. The most significant finding that emerges from this study is that the teachers must encourage the students for permission and playing games. In addition to this, the teachers need to use wireless technology, hand-held devices and other technological devices.

Bozkurt and Kumtepe [62] conducted a study in which they gave information about gamification, gamification processes, gamification model, gamification types and design processes. Examples of gamification are FourSquare, Nike+, eBay, SamsungNation, Microsoft RibbonHero. In spite of the positive sides of gamification, there has been negative criticism that it changes people's feelings and actions. Additionally, information was given about how and in what way gamification should be used.

Cordova and Lepper [63] carried out a study in order to determine educational computer programs for increasing the motivation of the students. To this end, they applied innovative teaching systems to the elementary school students. Based upon the results, individual differences were observed between traditional and innovative teaching systems.

Our main purpose of using gamification in this study is to help students steer away from boring test environments and improve their motivation and to create a competitive environment with badges and leaderboard that they receive and increase their success criteria.

2.4 Mobile Assessments

The use of Internet and smart phones affects all part of our lives. Such instruments have become the most important tools that we use all the time with the improvements on the mobile platforms. Saran et al. [64] suggested that with the accessibility of developing mobile technology and ergonomics, activities such as practice and application in educational field could be transferred to the outside of classroom. Corlett et al. argued that [65] it should be possible to benefit from mobile devices (e.g. PDA, smart phone, tablets) in the teaching-learning process through the support of educational institutions. Recently, we have often seen studies and researches about the presentation and use of mobile learning (e.g. education 66, 67, 73, business 71, 73).

Huang et al. [66] conducted a study in which they defended the idea that applications over PDA and smart phone are not enough for mobile learning. In the study, they added Google+ to get over the mobile learning restrictions. The findings revealed that attitudes and activities of the students advanced.

Chiang et al. [67] proposed the augmented reality-based mobile training instead of traditional ways of mobile assessments. The results showed that the success of the students using the proposed method increased. In addition, it was observed that those students' concentration, confidence and motivation were higher than the ones using the traditional method.

Hwang et al. [68] conducted a study in order to examine the effects of research-based mobile learning model on the students. The results of the study revealed that students who learn through proposed approach have a higher learning success and a less cognitive load than those who learn through traditional learning approach.

Huang [69] applied a research where he dealt with English teaching by using mobile assessment method. And he mentioned that although they talk about the advantages of mobile learning, researches that show the good sides of it are still not enough. The findings of the research were found to be satisfactory.

Ferdoisi and Bari [70] focused on the contributions of mobile assessments to the undergraduates' learning process. The findings highlight that mobile training offers many alternatives to preparing and learning the course material. The second major finding is that mobile learning provides affordable learning solutions for students because it presents accessible additional sources in contrast to traditional ways of learning.

In order to examine the effects of mobile training on business English, Teodorescu [71] carried out a research. The findings of the research suggested that the mobile assessment method used by the students during a session was much more successful than the traditional learning approaches.

Chu conducted a research [72] for determining the contributions of the learning strategies in mobile learning methods to students. Consequently, a method that was miss-designed and misapplied could have negative effects on the students and the performance and motivation expected could result in disappointment.

Yusri et al. [73] aimed to observe how ready the teachers are for mobile study platforms. This study has found that the teachers look optimistically to mobile applications. Because it is not expensive to access mobile learning, the teachers show a tendency to it.

Nabipour [74] conducted a research through smart phones with Android operating system to deal with the success level of mobile applications and traditional way of learning on the students. The findings examined with covariance analysis confirmed that mobile applications was more successful than the traditional ways.

Menzi et al. [75] applied a research so as to examine the use of mobile technology for educational purposes. They examined their academic ideas with the qualitative research method in a technology acceptance model. This study showed that most of the academics used mobile learning methods and they all planned to use those methods in the future. The second important finding was that mobile learning systems would

be common provided that problems with financial and technical support have been overcome.

The aim with the application to be designed is to reach the highest level of accessibility through preparing it on mobile platform. Even though people do not carry their computers with them all the time in today's world, they actually live together with mobile devices. Thus, they will have the chance to use the application at any time whenever they could.

2.5 Summary

The results in this chapter indicate that people who developed the ability to think analytically and logically have more creative and practical thinking. The people with this type of thinking need to be encouraged to recognize themselves and help them make choices. It can be clearly seen that gamification plays such an important role in terms of encouraging especially young people. It is achievable to educate young people who cannot stay away from technological devices such as tablets, smart phones through these devices. In general, therefore, it seems that the interest of young people in doing tests increases through the study used in gamification platform with mobile devices. In the next chapter, a methodology is proposed to conduct the research.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter describes the methodology of the thesis study. It starts with a brief definition of the qualitative techniques and how that can be used. Next, it explains focus group and Delphi method to specify the features of the mobile software to be designed and the questionnaire to be used and how its procedure and editing continue. The section explains the steps of Delphi method and its progress in detail. Finally, the frame of the software to be designed is described on the basis of the information obtained from the methods.

A general outlook on the prepared design, its process and how it works are shown in Figure 1.

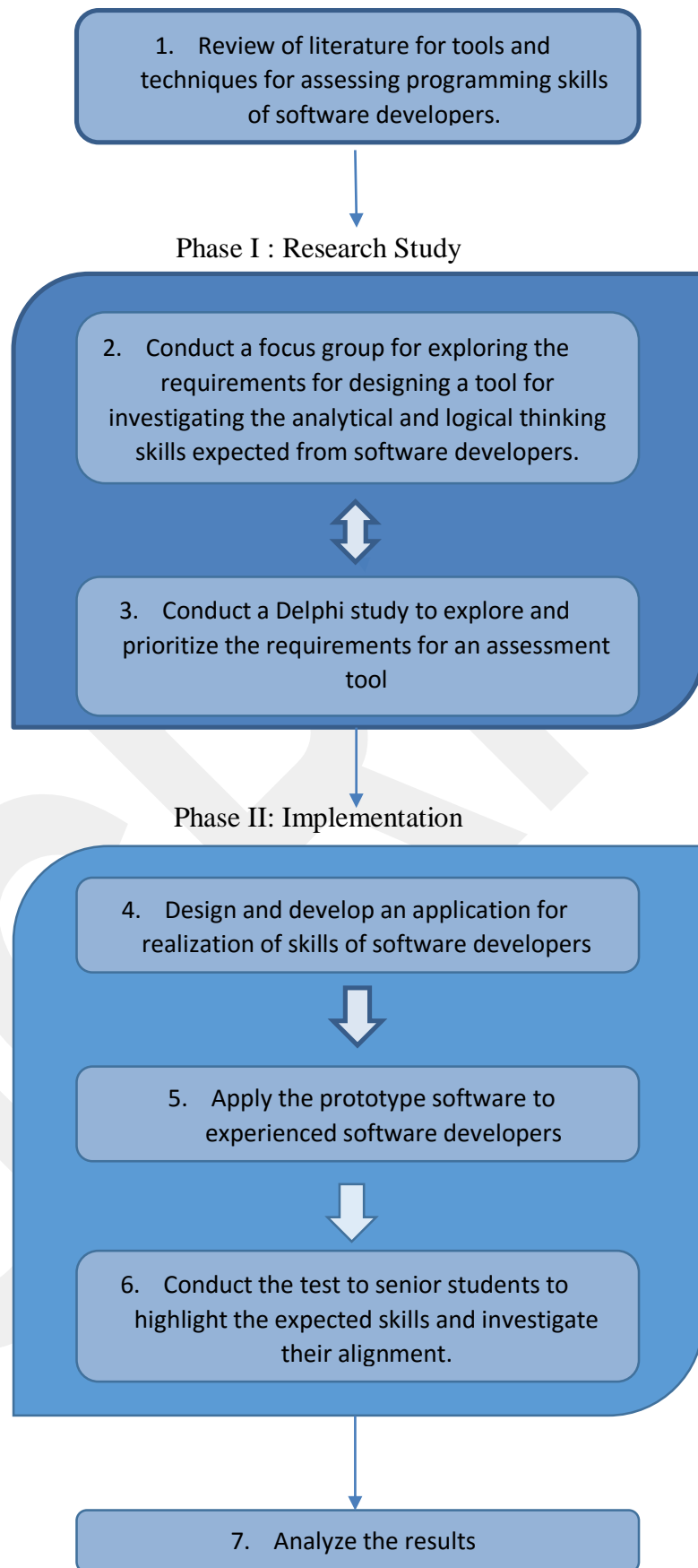


Figure 1: The Research design process

3.2 Qualitative Research

The term qualitative research refers to the type of research in which processes are followed to explain events as a whole by asking questions and receiving answers through observation [76]. This type of research usually looks for an answer for the 'why' question and examines human and social behaviors. In this research system, where no data is collected numerically, the basic technique is to receive a result by listening in a mutual conversation and intellectualizing the information obtained through observation.

In this study, data was collected from 2 different groups of experts through qualitative observation.

- 3 experts to form Focus group
- 7 experts to form Delphi Study

The purpose of using qualitative observation is to create a gamification and software design framework in order to increase the consistency and quality of the mobile application in the light of expert opinions and suggestions.

3.3 Quantitative Research

Quantitative research can be defined as measurement and explanation of the individual behavior in a social environment through observation, experiment and test objectively. For Muijs, [95] quantitative research refers to an analysis of numeric data collected from the questions asked or studies done by using mathematical and statistical methods. In the numerical (research) method, where there are 2 groups as experimental and control, the relationship between these 2 groups is specified through statistical methods.

In this study, the relationship between the focus group experts. And we calculate the Kendall's Coefficient of Concordance (W). This helps to determine the degree of

consensus among the experts. The more degree of consensus between the participants' increases, the validity of the common conclusion gets higher.

3.4 Research Validation

During this study, qualitative observation method of two stages was used in order to provide the validity, reliability and quality of the software to be designed and put into use in certain criteria.

In order to reach the goals of validation, the qualitative observation methods to be used are focus group and Delphi method. The reason why these methods were chosen was to ensure the participation of experts and reach the first-hand information.

We have three main titles, which were used in the two methods to be carried out: planning, data collection and analysis. In the first title, the validation of the titles in Table 1 was discussed as well as a focus group created by experts. The results obtained were listed. Delphi method was used with a group of different experts for the second method. Here the goal was to prioritize the titles obtained at the end of the elimination and change the contents, which were possible to change. The application phase of this plan is as follows (see Figure 2).

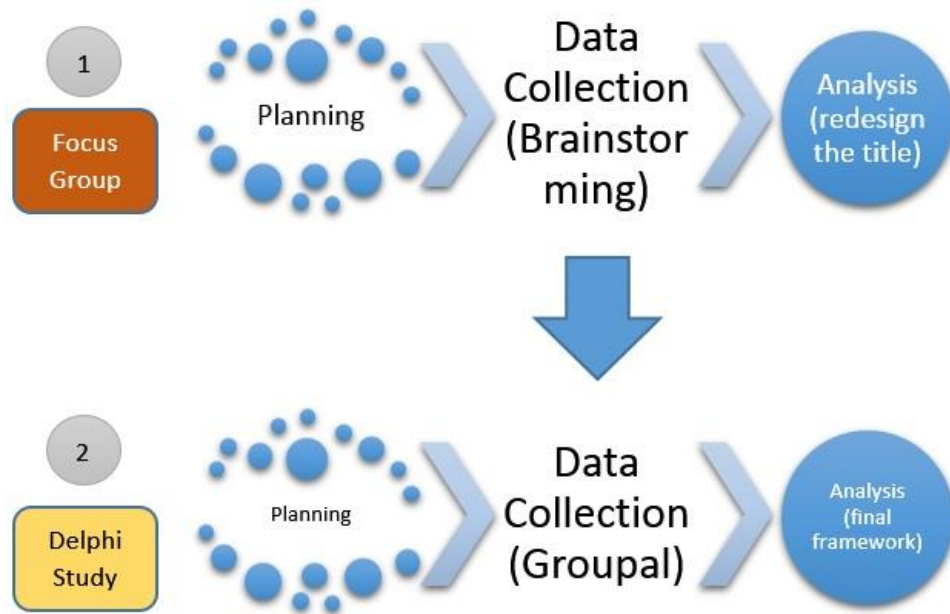


Figure 2: Stages and phases of validation, adapted from [93]

ORDER	TITLE	DEFINITION
1	Selection of test	The test to be applied should consist of least questions as possible.
2	Accessibility	The mobile application to be designed is enough for the target group.
3	Motivation	Gamification methods should be used in order to motivate the people taking the test.
4	Timing	There is no need for a time limitation during the test.
5	Clue	A clue should be given for answering the questions.
6	Comeback	The right to come back to the previous question and change the answer should be given.
7	Time Management	An award should be given according to the speed of solving the problems.
8	Repeatability	The test should be used by the same person again.

9	Real-time Feedback	The answer of each question should be given simultaneously.
10	Calibration	The calibration of the questions should be carried out according to the threshold value obtained earlier.
11	Presentation of the results	At the end of the test, the results should be ordered according to the leaderboard.
12	Avatar	Avatars should be assigned to individuals according to their success level.

Table 1: Implementation Framework for functional requirements

3.4.1 Focus Group

Focus Group is a study group of people picked out of experts on a specific topic. In order to identify the opinions and attitudes of those who join the group, the person conducting the research asks the participants predetermined questions. In the light of data obtained, in what way the planned study will be carried out is determined [96].

The main purpose of using focus group is to develop a richer understanding and a point of view by getting away individual opinions blended with hundreds of ideas about something [77]. The steps of process and the results will be discussed in three main titles.

a) Planning

Two gamification experts and one android developer expert were invited by e-mail in order to create the focus group (see Table 2). The average age of the experts was 35. All the experts invited accepted the invitation to make a contribution to the validation of the software to be conducted.

Expert ID	Title	Age	Education
E1	Android Developer	30	MSc.
E2	Assist. Prof. Dr. (Researcher)	35	PhD.
E3	Assist. Prof. Dr. (Researcher)	40	PhD.

Table 2: Expert Reviewers' Information for Focus Group

b) Data Collection

The session was started after all the experts gathered on skype calling and it continued for about 2 hours. Notes required were taken during the session.

All the titles and explanations were examined one by one. The facilitator explained the titles and the purposes of their formation and broached to the experts. An acceptance and a rejection list were made after getting the expert opinions. At the end of the session, both lists prepared by the facilitator were presented to the experts and it was verified that they were prepared according to their ideas.

c) Result and Analysis

The two lists prepared by the focus group are as follows:

- Validated List: 1, 2, 3, 5, 9, 10, 11, and 12. They are showed in Table 1.
- Rejected List: 4, 6, 7 and 8.

33.3% of the topics was rejected by the experts during the session and the reasons for their rejection were explained in Table 3. The titles (topics) accepted were transferred to the next section and Delphi method was applied.

ORDER	TITLE	REASON FOR REJECTION
4	Timing	<i>“The fact that there is no time limitation during the test may cause the individuals to catch a chance to cheat and it may not provide the principle of justice between the ones taking the test.”</i>
6	Comeback	<i>“Giving the right to come back to the answers will cause the individual’s time to think to drag out and this is something unwished for. This is because one of the goals of this test is to evaluate the practical and fast thinking of the individuals.”</i>
7	Time Management	<i>“Time criterion to be determined for solving the questions is an optimum time for the individuals who have a high ability of analytical and logical thinking. Solving the problems faster will not have a positive effect on their skills.”</i>
8	Repeatability	<i>“Giving the right to take the test by the same person again will cause the test to fall wide of the mark completely and the person will get a higher result compared with the first test result.”</i>

Table 3: Reasons for rejection

3.4.2 Delphi Method

Delphi technique, which is a Qualitative research method, is used to make a guess about the future by consulting experts. In 1946, Delphi method was used to identify security flaws especially in military by RAND Corporation in USA and it was used in the literature [78]. Besides military, Delphi technique was used in IT [79, 80] and education [81, 82].

The purpose of Delphi study is to reach the most accurate consensus in order to gather a panel of experts and ensure controlled feedback by conducting questionnaires [84]. The aim is to build consensus for the experts with different point of views for solving problems before they face the Delphi method. Delphi technique is building a structure where a group of individuals can communicate effectively in order to overcome complex problems [85].

There are several examples in the literature where Delphi method was conducted successfully. Jordan [79] utilized a two-round qualitative research in order to investigate how the development in semiconductor circuit elements affects the future of computer technology by using the Delphi technique. Gray [80] benefited from the Delphi techniques compiled by Roy Schmidt in order to find the critical success factors in cloud and cloud-based applications, which are used in electronic health record systems.

Tseng [81] carried out a three-round Delphi study to research the reason for music professors' lack of motivation and their resistance to participation in service training. To this end, Tseng consulted 17 experts. In order to investigate the difficulties that disabled people go through in natural disasters and create a special part for them in emergency action plans, Castaneda [82] examined the group of experts of disabled people and emergency action planners with a two round of Delphi study.

Because of arbiters' different point of views and different opinions for solving the same problem, the researchers can face the fact that the arbiters split in opinion. These differences of opinion can arise in issues such as what are the appropriate goals in the application to be carried out, which qualities the product should have, whether the goal can be accomplished or not. Delphi method is used as a tool for building consensus in situations like this where there are differences of opinion. Turoff and Hiltz [83] suggest that Delphi method should be used in emotional or politic situations or situations in which decisions can be influenced by powerful groups.

3.4.2.1 Features of Delphi Method

Delphi technique may be divided into three main categories: anonymity, statistical group response and controlled feedback [86].

a) Anonymity

It is a known fact that the success of Delphi technique is hidden in this feature. During the study, participants who suggest ideas remain anonymous. This allows participants to express their ideas freely without depending on the individuals. And it prevents the individuals from approving of a well-respected participant's opinion unconditionally.

If the name of a participant is very often mentioned with the problem suggested, if it is known who suggests which idea, if the participant is worried about his/her idea not being acceptable or if the participant thinks that his/her idea may bother the ones in higher status, then the participants may hesitate to express their ideas. For these reasons, the principle anonymity of Delphi method is necessary.

b) Statistical Group Response

After each Delphi questionnaire is conducted, it is analyzed statistically. One of the most suitable methods for performing an analysis is Kendall's W. This helps to determine the degree of consensus among the experts. The more degree of consensus between the participants' increases, the validity of the common conclusion gets higher.

c) Controlled Feedback

The results obtained after the statistical analysis of the consecutive questionnaires that is applied to experts in Delphi method is completed, that is to say general judgments arising from the ideas of the experts, are sent to the participants with the next questionnaire.

This gives the experts an opportunity to compare their ideas with different ideas and opinions.

In Delphi technique, questionnaires which are usually prepared in writing and sent by e-mail are used as a data collection tool. However, data is also collected in one-on-one meetings or via e-mail in certain cases. (The substance of the questionnaires is from quantitative objects) The contents of the questionnaires are determined with the participation of the researcher, participant or both.

3.4.2.2 Applying the Delphi Method

The implementation of Delphi method consists of 7 steps, where people [83] who are experts in this area or people [87] who represent this area suggest and examine their ideas and their point of views, and build a consensus for solving problem (Figure 3).

These steps are determination of the main purpose, selection of experts, receiving the ideas via e-mail, analysis of ideas, attempts to build common opinions, identification of the mutual points and use of the results. These will be examined in three main titles.

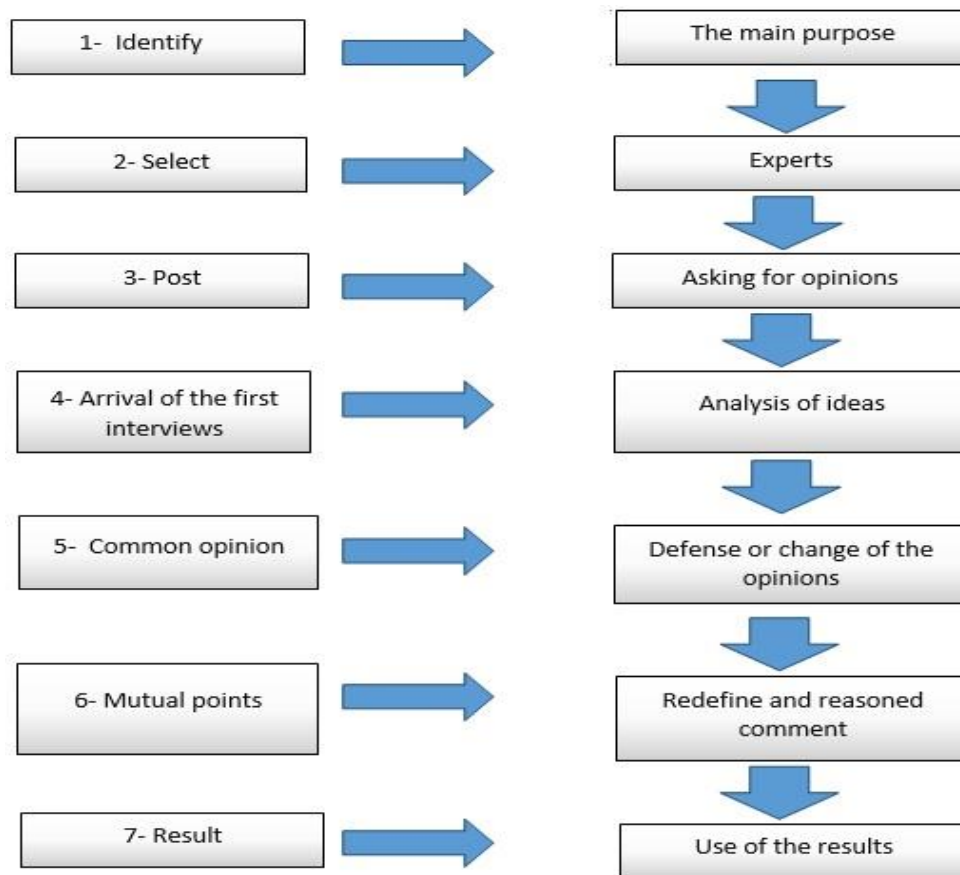


Figure 3: The steps of Delphi method, adapted from [88]

a) Planning

Planning consists of the first and second steps which are ‘identify’ and ‘select’.

The purpose of using Delphi method is to verify the titles accepted as accurate and applicable by focus group. 5 gamification experts and 5 software developer experts were invited by e-mail apart from the experts who were invited to the focus group. But only 4 gamification experts and 3 software developer experts accepted the invitation. The Delphi method applied consists of 2 rounds. In the first round, the titles accepted by focus group were asked to be prioritized starting with the items which did not need to change. In the second round, the changes that must be made in the related items and the reasons for these changes were asked to be identified. **Table 4** shows the experts’ job, age and education.

Expert ID	Title	Age	Education
E1	Android Developer	30	MSc.
E2	Java Developer	32	MSc.
E3	Software Tester	28	MSc.
E4	Assist. Prof. Dr. (Researcher)	35	PhD.
E5	Assist. Prof. Dr. (Researcher)	40	PhD.
E6	Assoc. Prof. Dr. (Researcher)	38	PhD.
E7	Assoc. Prof. Dr. (Researcher)	36	PhD.

Table 4: Expert Reviewers' Information for Delphi Study

b) Data Collection

In data collection, the titles accepted by focus group were sent to the experts who accepted to participate in the study. The experts were asked to prioritize the titles that were sent in the first round from high to low order. Next, they were asked to specify the changes in the items, which needed to change from low to high order. The common titles were corrected and presented to the experts for approval.

c) Result and Analysis

This title consists of the 4th, 5th, 6th and 7th steps of Delphi method where the analysis of the opinions, the change of the opinions, reasoned comments on these changes and the use of the results obtained from the experts are involved.

The results of the first round are presented in Table 5. Each of the results sent by experts is prioritized.

Position	Expert 1	Expert 2	Expert 3	Expert 4	Expert 5	Expert 6	Expert 7
1st	12	11	11	11	10	12	10
2nd	11	12	5	10	5	10	12
3rd	10	2	12	9	2	3	9
4th	9	10	10	5	12	2	11
5th	5	9	9	3	3	5	5
6th	3	5	3	10	11	9	3
7th	2	3	2	1	1	1	2
8th	1	1	1	2	9	2	1

Table 5: Round 1 classification of validated for each expert

Kendall's Coefficient of Concordance (W) can be considered as a measure (i.e. assessment) of the agreement between a group of experts who have rank ordered a set of entities, which is a value between zero and one. The high level of agreement is shown above 0.7, while a moderate agreement is valued around 0.5. The values below 0.3 are accepted as weak agreement. Our results indicate that $W = 0.575$ which means there is a moderate agreement between the opinion of the consulted experts.

From the data in Table 5 we can see that the 11. title was chosen for the first position by 3 experts. The 12. title was chosen for the second position by 2 experts. The ninth title was chosen for the third position. The tenth title was chosen for the fourth position by 2 experts. The fifth title was chosen for the fifth position by 3 experts. The third title was chosen for the sixth position by 3 experts. The second title was chosen for the seventh position by 3 experts. Finally, the first title was chosen for the eighth position by 4 experts. When ordering the titles, the top rated title was chosen in each position. If the vote rate of the same title in two positions had been the same, only that title would have been sent to the experts to vote. Based upon the results, the new ordering is shown in Table 6.

Position	Final Title
1st	(11) Presentation of the results
2nd	(12) Avatar
3rd	(9) Realtimefeedback
4th	(10) Calibration
5th	(5) Clue
6th	(3) Motivation
7th	(2) Accessibility
8th	Selection of test

Table 6: Final classification of validated

In the second round, information was obtained about the validity and stability of the content of the titles by experts. The experts were asked to identify which contents they needed to change, how they must be changed as well as the reasons for these changes. The contents and the details that experts asked to change are presented in Table 7.

Expert	Title	The changed content	Reason
Expert 1	Real-time Feedback	The answers should be given at regular intervals.	<i>“When the individual’s success has an effect on the ordering, the validity of providing guidance for the individual will increase.”</i>
Expert 2	Calibration	The average success of the ones taking the test should be used for the calibration results as well.	<i>“The mobile application will not be enough for the target group.”</i>
Expert 3	Accessibility	A web-based application can be carried out to support the mobile application.	<i>“The individual may not like the avatar to be assigned to and his/her motivation may be lower. Instead, a badge should be assigned to the individual. “</i>

Expert 4	Avatar	Instead of assigning an avatar, the individual should have the option to change his/her own avatar.	<i>“A lowness of motivation will be observed among the same group of friends taking the test.”</i>
Expert 4	Presentation of the results	Instead of ordering the test results, it is enough to give the score that the individual receives.	<i>“Instead of small rewards or badges, allowing the individual to solve the problems by playing games will increase his/her motivation.”</i>
Expert 5	Motivation	Instead of gamification, game-based learning should be used.	<i>“Seeing the results at the end of the test, instead of during the test will increase the feelings of enthusiasm and curiosity of the individual.”</i>
Expert 5	Realtime Feedback	Real-time results should not be given.	<i>“It motivates the individual more to see how close he is to reaching his goal, instead of knowing whether his each answer is true or false. “</i>
Expert 6	Realtime Feedback	The flow chart should be given instead of real-time results.	<i>“When the individual’s success has an effect on the ordering, the validity of providing guidance for the individual will increase.”</i>

Table 7: The contents that are asked to change and the reasons for these changes

The table obtained was sent to the experts for voting again. The experts sent the changes that their colleagues requested to be made to the method administrator by marking the ones which they thought were positive again. The administrator examined the tables which were marked and then determined the changes selected by a large majority and organized the application framework for its final form (Table 8).

ORDER	TITLE	DEFINITION
1	Selection of test	The test to be applied should consist of least questions as possible.
2	Accessibility	The mobile application to be designed is enough for the target group.
3	Motivation	Gamification methods should be used in order to motivate the individuals taking the test.
9	Real time Feedback	As the goal is approached, the process will continue.
10	Calibration	The course success of individuals will be taken into consideration in addition to threshold value for the calibration results.
11	Presentation of the results	At the end of the test, the results should be ordered as per leaderboard.
12	Avatar	Badges should be assigned to the individuals depending on their success level.

Table 8: Final Implementation Framework's

By the end of the study, the application framework, which was arranged in the light of expert opinions and verified by experts, took its final form. The applicability, reliability, validity and gamification (gaming) of the mobile application to be designed were achieved in the highest motivation level.

3.5 Summary

In this chapter, the design method of the study is specified. The type of the research to be conducted and which methods are used and the processes of the used methods are mentioned. Also, the framework of the mobile application, which will be designed according to the data obtained from Focus group and Delphi study, is determined. In the next chapter, the procedure of the application, which will be designed, is described and how the gamification methods are adapted to the application is explained.

CHAPTER 4

DESIGN AND IMPLEMENTATION

4.1 Introduction

This chapter explains our software application in detail. It describes the necessary groundwork and tools for our approach and how to utilize it. Additionally, the reason why these tools were chosen is explained. Then the design of the used database and the connection between the tables are defined. Finally, the formation process, the usage of the mobile application and the sheets are mentioned.

4.2 System Description and Requirement Analysis

This survey program, which is based on gamification, will be designed in order to identify the analytical and logical thinking skills of individuals. This platform will motivate the individuals to solve the survey questions and increase the rate of solving them. In addition, students will get an idea about their business life in future by solving the questions.

In this platform, there are 2 different user types for our system. These can be listed as follows:

- Administrator
- Students

The function of the system consists of selection of question types, which will be added into the system by an administrator and uploading them into the system.

University students or students preparing for university try to progress, in order to gain a badge and points by solving the questions. Web interface is planned to be used for administrator control and uploading questions. And android interface is planned to be used so that the question system prepared could reach the final user.

The functions and modules of the system are described in detail as follows:

- **Add New Admin:** In order that the application can be fit for purpose, an authorized administrator or administrators, who determine and design the survey types and survey questions which will be uploaded into the system, are needed. This module involves personal information of the administrators as well as their user name and password so that they could login to the system.
- **Add New Survey:** There might be more than one survey or more than one survey might be conducted in the application at the same time. Hence, the administrator needs to create a new survey before uploading any question.
- **Add New Question Type:** The questions which will be added can have different types and implementations. Therefore, it should be decided whether the question types are true-false, multiple-choice or classic before uploading the questions.
- **Add New Question:** There might be other types of questions apart from the 2 types of survey questions that we decide to add to the system. This module will help add new questions to our system.
- **Join the game:** The application is designed in a gamification platform. The users should feel that they join a game while they login to the application.
- **View Progress Bar:** After completing the application, the users should be able to follow how close they are to their goal when answering the questions through an instant progress bar.

- **View Overall Ranking:** After completing the application, the users should be able to see their ranking within the other users, their success score and the badge given to them at the end of the success they achieve.

4.3 Tools and Databases

4.3.1 MySQL Server

The term MySQL server refers to an open source database. It is supported by volunteer developers constantly and distributed with General Public License (GNU). The reason why we choose MYSQL for database is that we use android, that is to say, open source in other platform. PHPMYADMIN will be used, which is the oldest and commonly used program, for database management.

In our database, there are 8 tables. These can be listed as follows:

1. **ADMIN:** In this table, the aim of each administrator is to save the user name and password that users have to use, which is created by them, for logging to the system. In order for the users to store their personal information, ADMIN INFORMATION, which is a separate table, is used.
2. **ADMIN_INFORMATION:** This table is designed to store some personal information of administrators such as first name and last name.
3. **SURVEY:** There are 2 different surveys which we will use in our game platform. In order to separate the surveys from one another and connect with them, it is necessary to denominate and numerate the surveys in advance.
4. **QUESTION:** In this table we will store the questions which constitute these surveys. Each question should contain its title, its content and if available its question graphic in the database.

5. **QUESTION_OPTIONS:** This table will contain the options of questions, which option is correct and how many points is each option, graphics of question options, graphic extensions and orders.
6. **QUESTION_TYPE:** It is necessary to categorize the questions in advance so that different types of questions can be presented in the same survey. Questions can consist of multiple-choice, classic or gap filling questions. This table will help us distinguish these features.
7. **SURVEY_USER:** This table will keep the email addresses, the login date and the time of the users. The purpose of saving the email addresses of the users into the database is to prevent the same user from logging to the system again.
8. **SURVEY_SURVEYUSER:** In order to check whether the answers of the users are true, to give points, to determine their ranking depending on the success they achieve at the end of the test and to give the badge that they deserve, it is necessary to keep these things in a database and compare them. This table will help us fulfill these tasks.

The relationship between Mysql database tables is shown in Figure 4. It appears from the table that there are bidirectional flows and one-way flows. In bidirectional flows, there are bidirectional connections between the tables. And in one-way flows, successive tables are presented.



Figure 4: Database relationship diagram from purpose admin framework

4.3.2 Java Server Pages (JSP)

JSP can be defined as a server technology created for web pages and other online programs [89]. It works on the basis of embedding in the markup language such as HTML or PHP. In order for the JSP files to work as a server, JSP needs an application server.

One of the advantages is that a structure, which is created on JSP, works on any browser. Another advantage of it is that it is open to improvement and it is an open source software.

4.3.3 Spring Framework

The term spring framework refers to an useful solution to designing operational applications. Spring module only allows the parts, which we need during coding, to be used [90].

One of the biggest advantages is that Spring and Spring MVC make it easier to create web-based programs and fulfill the basic needs such as security and databank connections. The reason why we will use Spring Framework in the application is that only modules that will be used in the designed project can be chosen thanks to the modular structure.

4.4 System Functions and Module Implementation

As was mentioned in the previous chapter, this system helps us identify how close students are to their training goals. Hence, there are 2 types of users expected to login to the system. The first one is the administrator who will add content in the system and the other is students who will use the platform. Our design consists of two different platforms, which are web interface and android application. The surveys that each

admin user creates only belong to the ones who create them and they are not allowed to be seen or changed by another user. The home page of administrator panel is shown in Figure 5.



Figure 5: Admin Login Page

4.4.1 The function of administrator

Administrator is the only user who has direct access to the database in the designed system. Administrator is the person who adds the surveys, the question types which will be used in the surveys, explanations and answers of the question into the system. He can also determine the points of answers and see the scores received. The operations that the admin user could carry out are presented in the use-case diagram in Figure 6.

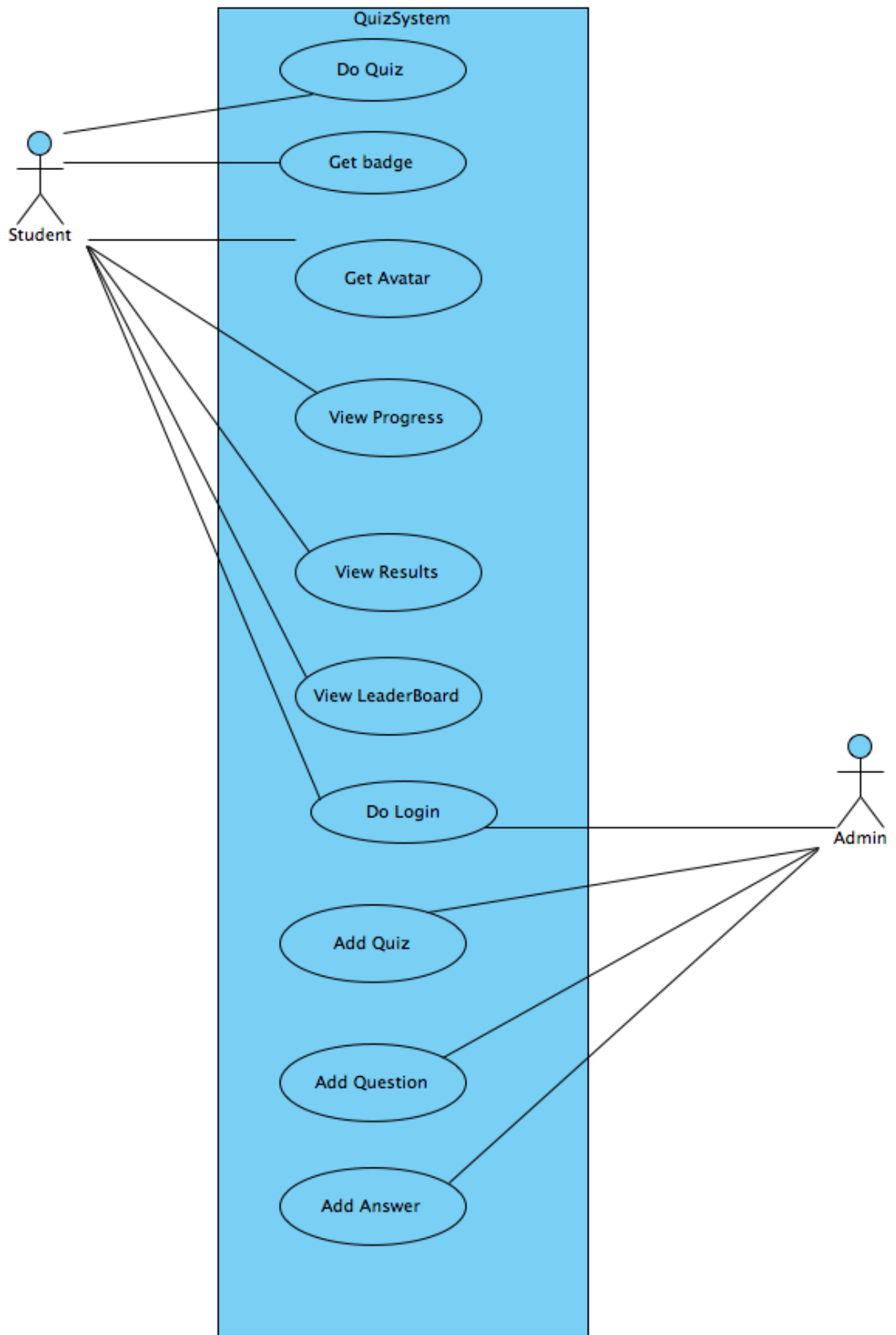


Figure 6: Use case diagram of overall system

4.4.1.1 Add new survey

After logging to the system, the first page the administrator will see is “Add Survey”, which is shown in Figure 7. This page allows the surveys to be added and listed which will be called while using the design in the mobile application.

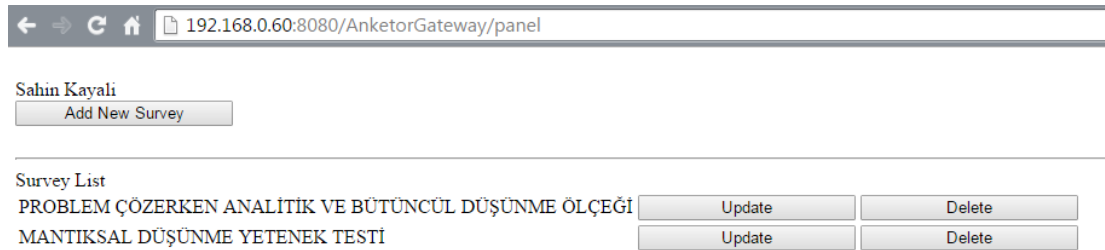


Figure 7: List of all surveys

When you press the button “add survey” in this window, a screen, in which the title, the definition and explanation of the survey can be added, is displayed. (Figure 8) We create the basic structure of our survey by adding required definitions through this page.



Figure 8: Add new survey page

4.4.1.2 Add new question

After determining the surveys and survey lists, the administrator directs the user to the page “add new question” in order to enter the survey questions. As shown in Figure 9, after identifying the question number, question definition, content of the question and question type, you press the “add” button.

Title	<input type="text"/>	Description	<input type="text"/>
Question Order Number	<input type="text"/>	QuestionType	Multiple Choice
Add Question			

Figure 9: Add new question page

After completing to create the questions, it is time to input the answers of questions and determine the correct option. To do this, you press the button “update” and move on to the page shown in Figure 10. In this page, answer options are determined and filled in based on the question types. Next, the correct option is chosen or the score which will be gained from the chosen option is determined. After pressing the “add” button, adding question is completed.

Order Char	Description	True / False
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
<input type="text"/>	<input type="text"/>	<input type="checkbox"/> Is true Or Enter selection value <input type="text"/>
Add Options		
Finish		

Question

22) - Bir boyacı, aynı büyüklükteki altı odayı boyamak için dört kutu boya kullandığına göre sekiz kutu boya ile yine aynı büyüklükte kaç oda boyayabilir? -

- M + M Choice

Delete Question

- Select file to upload / Update

Dosya Seç

Dosya seçilmedi

Upload / Update

- a) 7 oda -false -0
- b) 8 oda -false -0
- c) 9 oda -false -0
- d) 10 oda -false -0
- e) Hiçbiri -true -0
- 1) Oda sayısının boya kutusuna oranı daima 2/3 olacaktır -true -0
- 2) Daha fazla boya kutusu ile fark azalabilir. -false -0
- 3) Oda sayısı ile boya kutusu arasındaki fark her zaman iki olacaktır. -false -0
- 4) Dört kutu boya ile fark iki olduğuna göre, altı kutu boya ile fark yine iki olacaktır. -false -0
- 5) Ne kadar çok boyaya ihtiyaç olduğunu tahmin etmek mümkün değildir. -false -0

Remove Option

Remove Option

Remove Option

Remove Option

Remove Option

Remove Option

Remove Option

Remove Option

Remove Option

Remove Option

Figure 10: Update question page

4.4.2 Login the Implementation

Students who will use the designed application start to implement it by entering their email address via the screen shown in Figure 11. The users cannot login to the system twice with the mail address they use here.

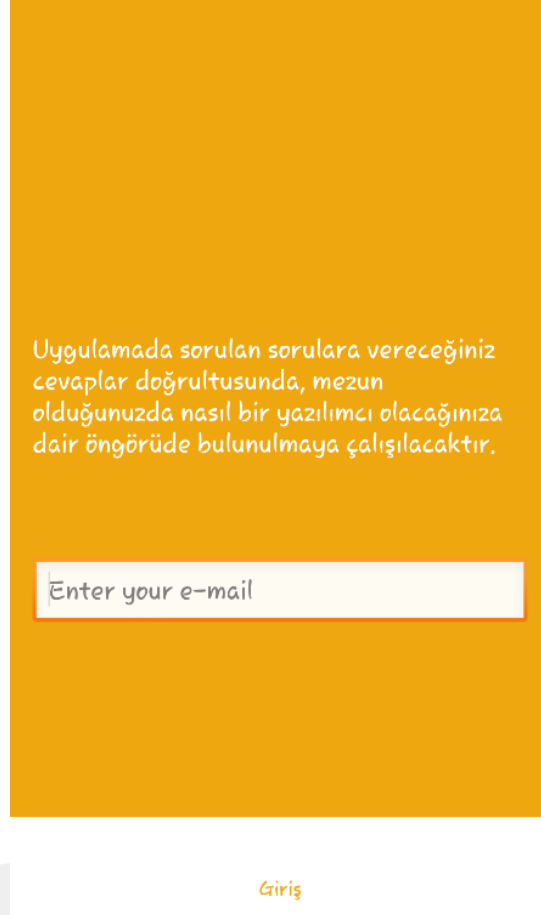


Figure 11: Android Login Page

4.4.2.1 Answer the Questions

After logging to the system using an email address, the explanation of the survey to be solved by users is displayed. (Figure 12)

PROBLEM ÇÖZERKEN ANALİTİK VE BÜTÜNCÜL DÜŞÜNME ÖLÇEĞİ

Herkesin bir düşünme stili vardır. Bu düşünme stillerinden hiçbiri diğerlerinden daha "iyi" ya da daha "kötü" değildir. Burada sizin problem çözerken daha çok hangi düşünme stilinde düşündüğünüz belirlenmeye çalışılmaktadır. Lütfen size en yakın gelen seçeneği işaretleyiniz. Nasıl düşündüğünüzü ayırt edemediğiniz maddelerde "fikrim yok" seçeneğini işaretleyiniz.

MANTIKSAL DÜŞÜNME YETENEK TESTİ

Bu test, çeşitli alanlarda, özellikle Fen ve Matematik dallarında karşılaşılabileceğiniz problemlerde neden-sonuç ilişkisini görüp, problem çözüme stratejilerini ne derece kullanabileceğinizi göstermesi açısından çok faydalıdır. Bu test içindeki sorular mantıksal ve bilimsel olarak düşünmeyi gösterecek cevapları içermektedir. (1-8. soruların her iki şıkkında da kendinize uygun olanı işaretleyiniz, 9-10. sorularda bulduğunuz cevabın rakamsal değerini yazınız)

Başla

Başla

Figure 12: Survey Description

The questions begin to be displayed after pressing the button under the survey explanation page. An example of multiple-choice question is shown in Figure 13 and the example of classic question is presented in Figure 14. Once the questions are displayed, users are not allowed to move on to the next question without choosing one of the answer options. In addition, the answered questions cannot be changed since the back button does not work in the design.

1

Bir boyacı, aynı büyüklükteki altı odayı boyamak için dört kutu boya kullandığına göre sekiz kutu boya ile yine aynı büyüklükte kaç oda boyayabilir?

a)7 oda

b)8 oda

c)9 oda

d)10 oda

e)Hiçbiri

1)Oda sayısının boya kutusuna oranı daima 2/3 olacaktır

2)Daha fazla boya kutusu ile fark azalabilir.

3)Oda sayısı ile boya kutusu arasındaki fark her zaman iki olacaktır.

4)Dört kutu boya ile fark iki olduğuna göre, altı kutu boya ile fark yine iki

Devam

Figure 13: Multiple Choice Question

9

Bir pastanede üç çeşit ekmek, üç çeşit et ve üç çeşit sos kullanılarak sandviçler yapılmaktadır. Her bir sandviç ekmek, et ve sos içermektedir. Tek se-ferde yalnızca bir ekmek çeşidi, bir et çeşidi kullanılarak kaç çeşit sandviç hazırlanabilir? Örnek: BSK= Buğday, Salam ve Ketçap dan yapılan sandviç

<u>Ekmek Çeşitleri</u>	<u>Et Çeşitleri</u>	<u>Sos Çeşitleri</u>
Buğday (B)	Salam (S)	Ketçap (K)
Çavdar (Ç)	Piliç (P)	Mayonez (M)
Yulaf (Y)	Hindi (H)	Tereyağı (T)

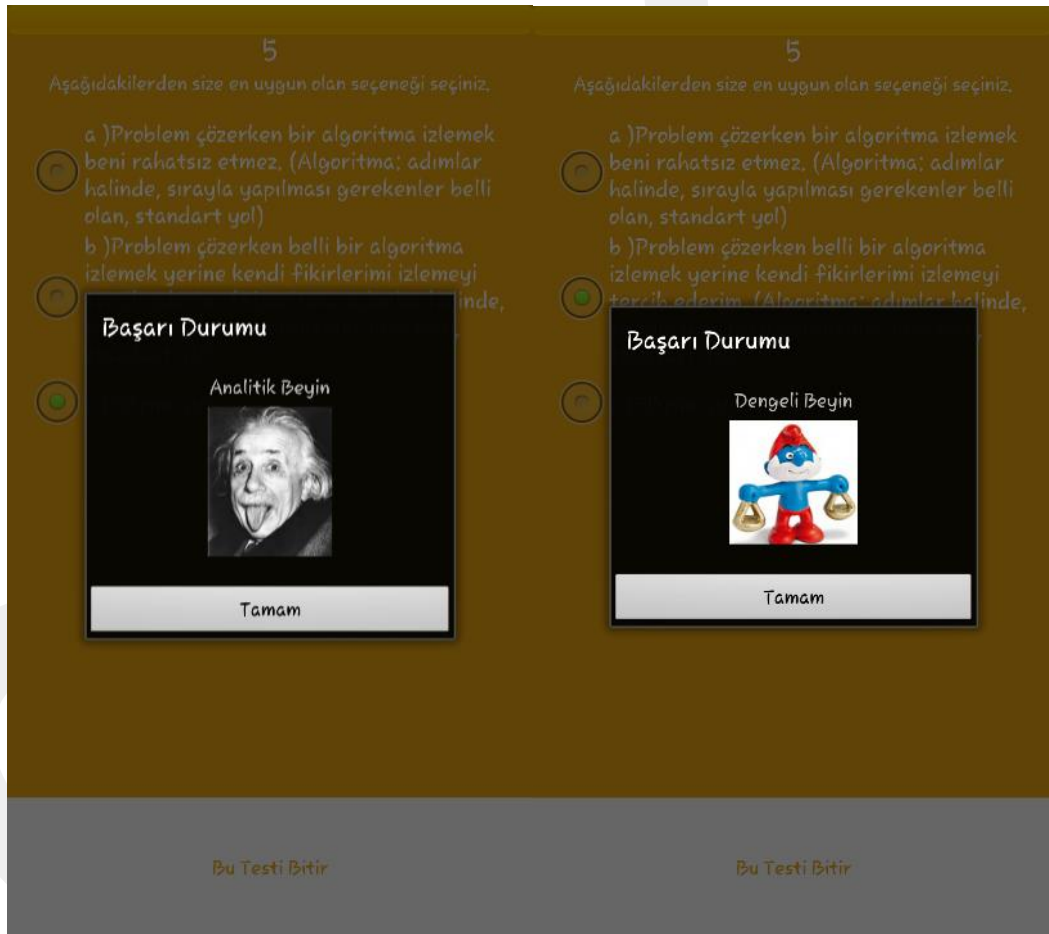
2

Devam

Figure 14: Classic Question

4.4.2.2 Overall Ranking

After the users solve all of the survey questions in the application, the answers to the questions are sent to the database in our online system and evaluated here. Based upon the results of evaluation, the success and the badge that the users reach are determined. Additionally, the success of each user is compared with the other users' success and then their ranking is identified. As shown in Figure 15, the ranking and the badge are presented to the user.



5


Aşağıdakilerden size en uygun olan seçeneği seçiniz.

a)Problem çözerken bir algoritma izlemek beni rahatsız etmez. (Algoritma; adımlar halinde, sırayla yapılması gerekenler belli olan, standart yol)

b)Problem çözerken belli bir algoritma izlemek yerine kendi fikirlerimi izlemeyi tercih ederim. (Algoritma; adımlar halinde,

Başarı Durumu

Bütüncül Beyin



Tamam

Bu Testi Bitir

5


Aşağıdakilerden size en uygun olan seçeneği seçiniz.

a)Problem çözerken bir algoritma izlemek beni rahatsız etmez. (Algoritma; adımlar halinde, sırayla yapılması gerekenler belli olan, standart yol)

b)Problem çözerken belli bir algoritma izlemek yerine kendi fikirlerimi izlemeyi tercih ederim. (Algoritma; adımlar halinde,

Zamanlama Ödülü

Zaman Rozeti Kazandınız



Tamam

Bu Testi Bitir

Tebrikler !

Başarı ile testi tamamladınız. Sıralamadaki yerinizi ve derecenizi görmek için devam a dokunun.



Başarılı bir yazılımcı olabilmek için daha fazla emek vermen, inanman ve çabalaman gerekiyor.

Devam

Tebrikler !

Başarı ile testi tamamladınız. Sıralamadaki yerinizi ve derecenizi görmek için devam a dokunun.



Başarılı bir yazılımcı olabilmek adına doğru yoldasın, hedefine ulaşabilmek için çok az yolun kaldı. Biraz daha gayret gösterirsen başaramaman için hiçbir engel yok.

Devam

Tebrikler !

Başarı ile testi tamamladınız. Sıralamadaki yerinizi ve derecenizi görmek için devam a dokununuz.



Başarılı bir yazılımcı olabilmek için biçilmiş kaftansın. Yolundan sapmadan emin adımlarla ilerlemeye devam et...

- 1 - silacakic@gmail.com
- 2 - esinuz@gmail.com
- 3 - bugracann@yahoo.com
- 4 - cemilk@hotmail.com
- 5 - cemozem@live.com
- 6 - aybur@hotmail.com
- 7 - omerer@gmail.com
- 8 - mertali@outlook.com
- 9 - yigitsu@gmail.com
- 10 - kkadriye@hotmail.com

Devam

Kapat

Figure 15: Overall ranking and badge pages

4.5 Summary

In this chapter, the procedure of the prepared design and how the other steps work in gamification and the program are described. In the next chapter, who used this prepared design is explained and the data received from the users is analyzed and the results are defined.

CHAPTER 5

ANALYSIS AND TEST RESULTS

5.1 Introduction

The current study involves an investigation of the effects of analytical and logical thinking skills on student life and business success of computer engineers and software developers. To accomplish this aim, SOHAT and TOLT, which have been used before and were proved to be valid, are used. The tests, which aimed to identify the success of these abilities on professional life, are applied to the software developers and control group is created. Furthermore, the success rates of the test applied to students of computer engineering are compared to the scores in class and the impact of these abilities on the success of school subjects is testing. The details of the studies are described respectively and shown in tables. Then the results are analyze and explain.

5.2 Control Group

The aim was to identify the business success of students who studied at the department of computer programming, after they graduated. To this end, the analytical and logical thinking abilities of 20 computer programmers, who began to work, were measured.

- SOHAT and

- TOLT surveys were conducted.

5 were the lowest point and 15 were the highest point according to the values of SOHAT results determined by Umay [25]. It was also determined that the ones who got 5, 6 and 7 points had a dominant ability of analytical thinking and the ones who got 12, 13, 14, 15 points had a dominant ability of integrative thinking.

According to the score intervals of evaluation of TOLT results, the ones who had a low, average and high level of logical thinking abilities were identified. According to this, the ones who are in 0-3 scores have a low ability of logical thinking, the ones who are in 4-6 score intervals have an average ability of logical thinking, and the ones who are in 7-10 score intervals have a high level ability of logical thinking [91].

The scores that the computer engineers received from the surveys are presented in Table 9.

SOHAT	TOLT
9	9
11	3
13	2
7	5
7	6
8	6
7	6
9	6
9	6
9	6
9	5
8	6
9	6
10	6
9	4
9	8
9	4
9	9
9	8
9	8
9	8
7	7
9	7
5	7
7	7
7	7
7	7
7	9

Table 9: Control group test results

The distributions of the scores that the computer engineers received are shown in Table 10 and the graphical display of percentage distributions is shown in Figure 16 and the success distribution of test results is presented in Figure 17.

SOHAT			TOLT		
Analytical	Neutral	Integrative	Low	Average	High
8 people	19 people	1 person	2 people	12 people	14 people
% 29	% 67	% 4	% 7	% 43	% 50

Table 10: The Distribution of Control Group Test Results by Significance Level

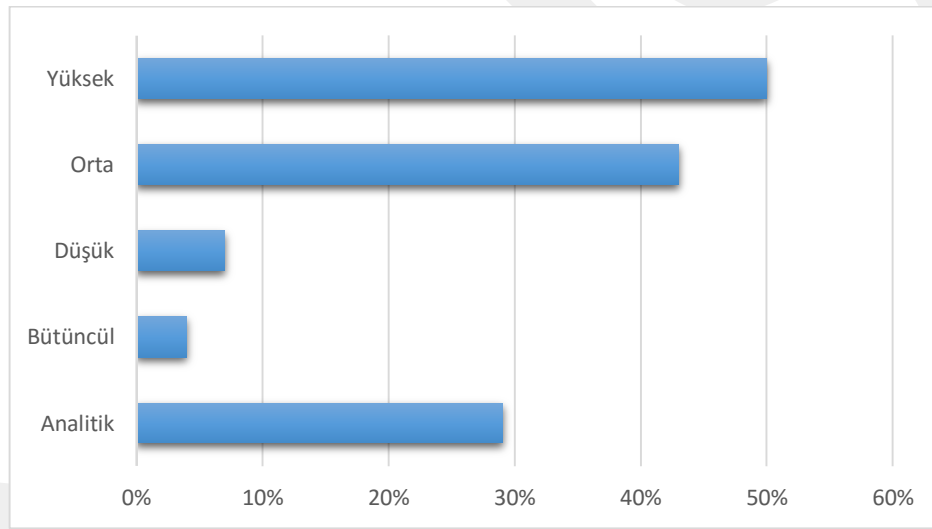


Figure 16: Percentage Distribution of Control Group Success

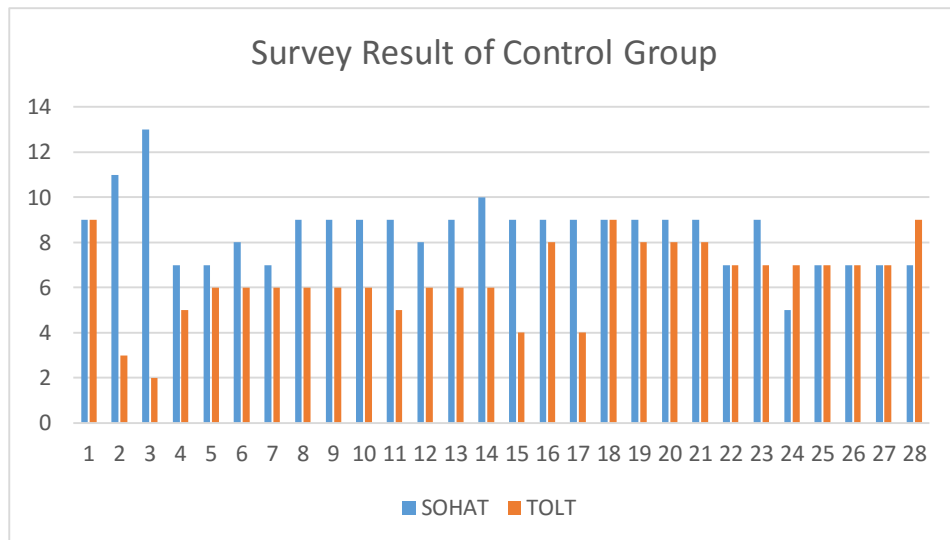


Figure 17: Success Distribution of Control Group

At the end of the SOHAT, the neutral ones were left out of assessment [25]. When this section, which constitutes 67% of results, is ruled out, the remaining part is 33%. The individuals who constitute 29% of 33% are individuals with analytical thinking ability.

The findings of TOLT percentage distributions reveal that individuals who have a high level of logical thinking ability with 50% are the largest mass. The findings also show that individuals with 43% have an average level of logical thinking ability and finally, individuals with 7% have a low level of logical thinking ability.

The results of the tests applied to the control group show that the individuals, who have a dominant structure of analytical and logical thinking according to the percentage distribution and success score distributions, became an engineer and continue their career successfully.

5.3 Experimental Group

The same tests applied to the control group were exercised in order to determine the success that computer engineering students as experimental group will get in business life after they graduate and the results were analyzed. As an experimental group, 23 students of computer engineering were got involved.

The scores that the students got from the surveys are presented in Table 11 and the graphical representation of the scores is shown in Figure 18. The percentage distribution of the scores by individuals is presented in Table 12 and the graphical display of percentage distribution is given in Figure 19.

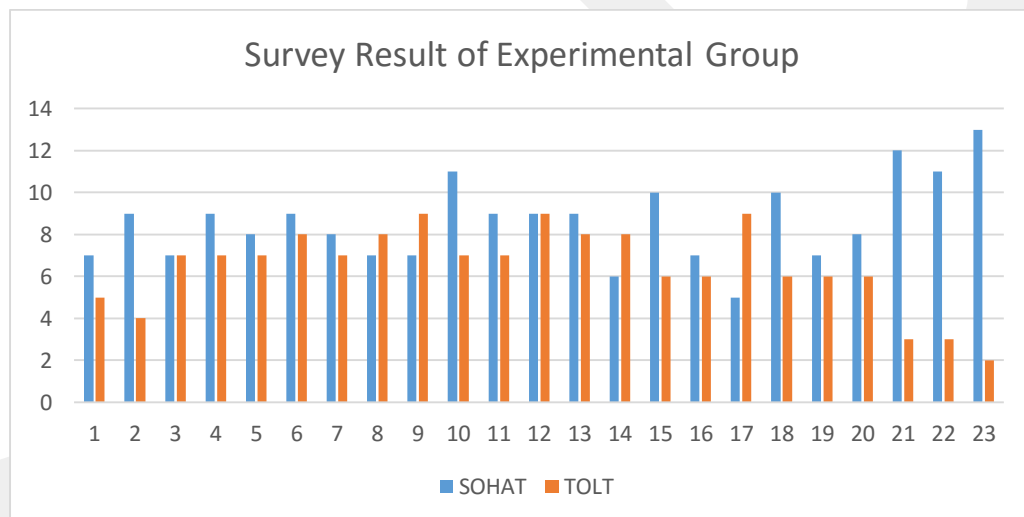


Figure 18: Success Distribution of Experimental Group

SOHAT	TOLT
7	5
9	4
7	7
9	7
8	7
9	8
8	7
7	8
7	9
11	7
9	7
9	9
9	8
6	8
10	6
7	6
5	9
10	6
7	6
8	6
12	3
11	3
13	2

Table 11: Test Results of Experimental Group

SOHAT			TOLT		
Analytical	Neutral	Integrative	Low	Average	High
7 people	15 people	1 person	3 people	8 people	12 people
% 30	% 65	% 5	% 13	% 35	% 52

Table 12: The Distribution of Experimental Group Test Results by significance levels

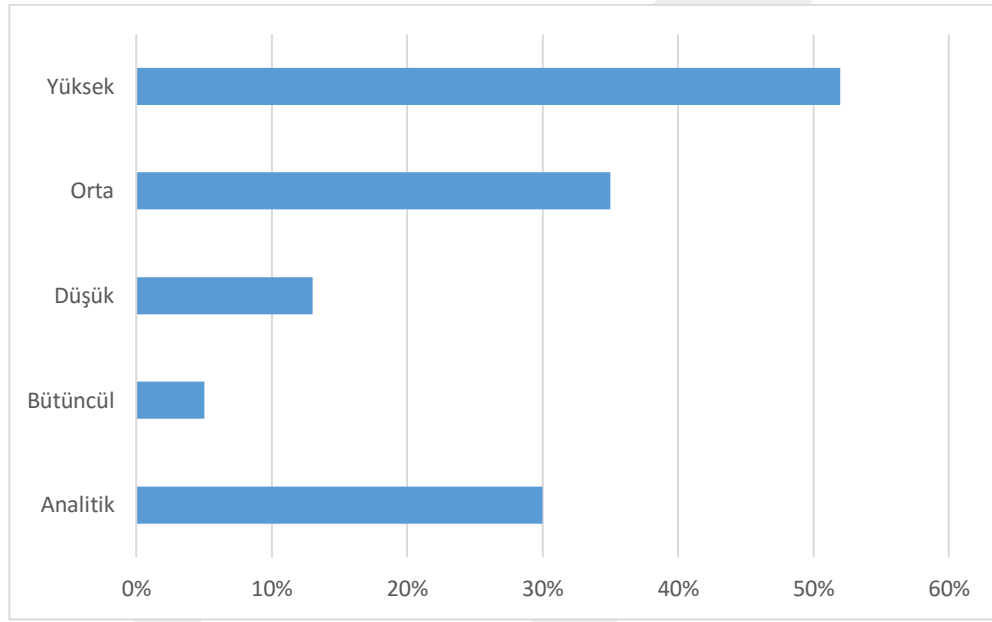


Figure 19: The Percentage Distribution of Experimental Group Success

The results of the surveys and the graphics demonstrate that 65% of the results is the neutral part, which is eliminated. What is left is 35%. The individuals who constitute 30% of the remaining part with 35% are individuals with analytical thinking ability.

The findings of TOLT percentage distributions show that individuals who have a high level of logical thinking ability are the largest mass with 50%. The findings also suggest that individuals with 35% have an average level of logical thinking ability and finally, individuals with 13% have a low level of logical thinking ability.

Comparing the results of control group and experimental group, it can be seen that the 12 students who constitute experimental group with 52% can achieve success in

business life in future. Also, it can be seen that the group of 8 students who has an average level of logical thinking ability with 35% need to work a bit more and improve themselves before they begin to work. The results also reveal that the remaining 13% section must work really hard in order to begin to work and reach success or they can prefer other fields of computer engineering apart from software development.

5.4 Validation Interviews

Interviews were conducted with software developer experts in order to improve the validity of the design we developed to use in our study. 4 experts were contacted. First, the design was applied to the experts and then they were asked to give information about the process of the design, possible problems, the effects of the design on individuals and what to do in future. The answers of the experts can be listed as follows:

- **Expert 1:** *“The design developed is colorful and pleasant from the very beginning. It creates the desire to solve the problems without getting bored. I did not encounter any problem as to the way it works during the processing time and it really works uncomplicatedly. It is useful that there is an explanation before each test. The 3rd level badge gained at the end of the application can make the user feel the joy of success and pride. I think that it will create a competitive environment for the students using the application and thus, their success levels will increase.”*
- **Expert 2:** *“A disposable mail address for entry is a successful precaution for creating a fair competitive environment between the ones using the application. The design is successful and fit for purpose in terms of its general structure. Students have an opportunity to compare themselves with individuals who work as a software developer and make a guess about their future position through the feedback at the end of the application. In my opinion, this is a motivating application for them.”*

- **Expert 3:** *“The template used in the design is successful in terms of ergonomics. Because the design measures the thinking competency, it is good that the back button does not work. This way, individuals do not have the opportunity to change the first answer they give and the determination of the results will increase. When the level of badge that individuals receive is low, it will be encouraging, even if it causes disappointment for that moment. “*
- **Expert 4:** *“Its design is mostly simple but fit for purpose. The explanations given before moving on to the questions are enough. The results received from the tests are enough to achieve the goal. In my opinion, the more the number of students using the application increases, the more determination in the order will be. The application will lead not only to university students but it will also lead to students preparing for university.”*
- **Expert 5:** *“I think that the application and the questions related to thinking abilities are fit for purpose. The application is simple and useful. In order to see the reward I would get and my grading at the end of the test, I solved the questions curiously by having fun. I found that the evaluation was accurate and determined at the end of the application and I really believe that it should be used to lead to individuals. To improve the application, the number of target audience can be increased by adding relevant questions to fields of engineering.”*

Expert	Comment
1th	<i>“colorful and pleasant – solve the problems without getting bored – the user feel the joy of success and pride”</i>
2nd	<i>“design is successful and fit – students have an opportunity to compare themselves”</i>
3rd	<i>“design is successful in terms of ergonomics – it is good that the back button does not work – the level of badge”</i>
4th	<i>“design is mostly simple – the results are enough – the application will lead not only to university students”</i>
5th	<i>“the application and the questions related to thinking abilities are fit for purpose – simple and useful – solved the questions curiously by having fun”</i>

Table 13: Summary of experts’ comment

5.5 Threats to Validity

Potential factors, which can affect the results of the study in a negative way and reduce the validity and reliability of them are defined as threats to validity [92]. Because the coefficient of validation was tested by the people who prepared the tests before and proved to be accurate, there was no need to calculate it again.

There might be some threats which affect the results negatively in our study as well. These threats can be listed as follows:

- The student may create a fake email account and have the chance to use the application again.
- The student may find out about the questions from his/her friend and see the questions while someone else answering them and make a guess about the results before.

- The student may have the chance to reach the questions and answers before as the survey questions have been already published in many surveys.

Although we are very careful about the threats that might affect our study negatively and take precautions against them, the results of the study may be adversely affected for the reasons above.

5.6 Summary

In this chapter, the data from the users and the results obtained from the application are described. 5 experts are consulted in order to identify whether the design achieved its goal and to increase its reliability. Also, the experts are asked to describe the pros and cons of the prototype application. In the final chapter, an outline of the study is given and what is planned to do with this study is defined.

CHAPTER 6

CONCLUSION AND FUTURE WORK

The aim of this thesis is to develop a tool to assess the analytical and logical thinking skills for computer engineering students to explore the potential success of students' as software practitioners when they start working at the software industry. To this end, there has been a necessity to identify the common features between individuals who finished their engineering education and began to work and students from the department of engineering or student applicants. As a result of the study, different styles of thinking were examined for representing the common characteristics of the individuals. The results showed that many of the researches conducted on engineering and sciences focused on logical and analytical thinking abilities. TOLT and SOHAT were chosen for the study due to the fact that these tests are commonly used in different fields, were proved to be reliable and are easy to implement. In order for the individuals to solve this test, a set of game elements, which were developed to increase participant's motivation was designed. Consequently, a competitive environment that provides instant results was built. Also, smart phone applications were designed to make the transportability easier. The importance of thinking skills and the contributions of mobile learning when implementing them were described and our research methodology was explained. It was explained why Delphi study, which is a technique of Qualitative Research, was used and the procedure of the study were mentioned. The structure of the application designed according to a focus group study and the Delphi method was used to negotiate a group of experts. Finally, using the developed product, the results of SOHAT and TOLT, which were applied to the software developers and the students, were analyzed. The results indicate that more than 50% of computer engineering students and the ones who began to work are the ones who developed their analytical and logical thinking abilities.

The findings reveal that these abilities of individuals have a strong effect on the success of being a software developer. Then SOHAT and TOLT were applied to the university students and similar results were found. When comparing the two groups, it can be seen that there is no obstacle that can stand in the way of half of the students being a successful software developer. Additionally, this test may be helpful for the student group preparing for university about whether they should study at the department of computer engineering or not. In addition to the test results, senior software developers were interviewed in order to strengthen the validation of the application designed and the methodology used.

The remarks obtained from the study can be summarized as follows:

- The platform creates an opportunity for students to assess themselves. In particular, individuals who are worried for their future success. Gamification can help them to overcome their concerns in a fun way.
- Based on the game elements, their confidence will grow thanks to the badges given as a reward and they will focus better not to decrease their success.
- The proposed application promotes the students to observe their skill levels.
- The gamification creates a competitive environment especially for participants to keep up with the others in a leaderboard.
- University applicants should benefit from the application. They will see the ordering between graduate engineers and students of engineering and thus, they will make a more conscious choice for a department.

The method used and the software designed achieved their purpose and met the experts' expectations. By adding additional options, the design can be developed. Thus, people who will decide to study computer engineering can be sure of their decision.

First of all, what we are planning to do is to improve the gamification techniques in the design, which consist of gamification platform so that the tests could be more enjoyable and more motivating. Furthermore, we are trying to make it possible for this design, which can only be accessed from mobile platforms, to reach from a web-based platform so that it will reach larger audiences as well.

Finally, the prototype, which was developed can be used not only in computer engineering but also be beneficial to use in other domains that needs skills of analytical and logical thinking skills. When it comes to engineering, mathematical analysis cannot be separated from each other. Based upon the foundations of engineering concepts, questions, which contain other types of questions, can be formed and added to the tool so that a wide range of engineering students could benefit from such a platform as well.

Each year, Turkish universities have a career week for departmental advertisements, in which university applicants have the opportunity to gain information about the university departments. It has become usual to encounter individuals who want to study at the department of computer engineering only because they like to use computer applications. Individuals, however, do not have enough information about the education they will receive or the success they will catch. In order to prevent this uncertainty that the students are going through, the tool that we carried out can be presented to the students who join the introduction day or conduct research far away by making an agreement with universities. The students can understand the fact that it is not only necessary to love playing computer games but it is also vital to have certain abilities in order to study at the department of computer engineering. Students who have sufficient abilities to be a software developer can determinedly choose their department, whereas students who have abilities in different fields can realize this and be interested in other departments. Thus, the new generation can be led to the departments in which they can be mostly successful depending on their abilities. The school success of this new generation can increase and more helpful individuals can grow for our country.

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APPENDICES A

CURRICULUM VITAE

PERSONAL INFORMATION

Surname, Name: Kayalı, Şahin

Date and Place of Birth: 01 January 1990, Ankara

Marital Status: Single

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EDUCATION

Degree	Institution	Year of Graduation
M.Sc.	Çankaya Univ., Computer Engineering	2015
B.Sc.	Gazi Univ., Electronic Teaching	2012
High School	Yenimahalle Anatolian Technical High School	2007

WORK EXPERIENCE

Year	Place	Enrollment
2014-2015	Teknomar Makine Ltd.	Specialist
2010-2012	Kaysantaş Inc.	Manager
2008-2010	Timurlar Sigorta	Specialist

APPENDICES B

ANALİTİK VE MANTIKSAL DÜŞÜNME TESTİ

Sevgili arkadaşlar;

Size verilen bu test 5 Adet analitik ve bütüncül düşünme ölçeği sorusu ve 10 Adet mantıksal düşünme yetenek testi olmak üzere 15 Adet sorudan oluşmaktadır. İlk bölümdeki 5 sorunun altında bulunan “()” içerisine sizi uygun gelen seçeneği işaretleyiniz. İkinci bölümdeki soruların sonunda bir cevap tablosu bulunmaktadır, cevaplarınızı oraya yazabilirsiniz.

İSİM :

CİNSİYET:

YAŞ:

MESLEĞİ:

UZMANLIK ALANI:

TARİH:

Başarılar..

BÖLÜM I

PROBLEM ÇÖZERKEN ANALİTİK VE BÜTÜNCÜL DÜŞÜNME ÖLÇEĞİ

SORU NO	Herkesin bir düşünme stili vardır. Bu düşünme stillerinden hiçbiri diğerlerinden daha “iyi” ya da daha “kötü” değildir. Burada sizin problem çözerken daha çok hangi düşünme stilinde düşündüğünüz belirlenmeye çalışılmaktadır. Lütfen size en yakın gelen seçeneği işaretleyiniz. Nasıl düşündüğünüzü ayırt edemediğiniz maddelerde “fikrim yok” seçeneğini işaretleyiniz.		FIKRİM YOK
1	Bir problemi çözerken tahmin, deneme-yanılma gibi yöntemleri pek kullanmam. ()	Bir problemi çözerken tahmin, deneme-yanılma gibi yöntemleri sıkça kullanırım. ()	()
2	Problem nasıl çözdüğümü anlatmakta genellikle zorlanmam. ()	Problemi nasıl çözdüğümü anlatmam istendiğinde genellikle nasıl düşündüğümü açıklamakta zorlanırım. ()	()
3	Problemi çözmeye çalışırken genellikle çözüm bir anda gözümün önüne gelir. ()	Problemi çözerken genellikle çözüm süreç içinde şekillenir. ()	()
4	Kimi zaman bir problemi çözdüğümde çevremdekilerin sanki sonucu rastlantıyla bulmuşum gibi kuşkuyla baktıklarını hissederim. ()	Bir problemi çözdüğümde çevremdekilerin sonucu rastlantıyla bulduğumdan kuşkulandıklarını hatırlıyorum. ()	()
5	Problem çözerken bir algoritma izlemek beni rahatsız etmez. (Algoritma: adımlar halinde, sırayla yapılması gerekenler belli olan, standart yol) ()	Problem çözerken belli bir algoritma izlemek yerine kendi fikirlerimi izlemeyi tercih ederim. (Algoritma: adımlar halinde, sırayla yapılması gerekenler belli olan, standart yol) ()	()

BÖLÜM II

MANTIKSAL DÜŞÜNME YETENEK TESTİ

AÇIKLAMA: Bu test, çeşitli alanlarda, özellikle Fen ve Matematik dallarında karşılaşabileceğiniz problemlerde neden-sonuç ilişkisini görüp, problem çözme stratejilerini ne derece kullanabileceğinizi göstermesi açısından çok faydalıdır. Bu test içindeki sorular mantıksal ve bilimsel olarak düşünmeyi gösterecek cevapları içermektedir.

NOT: Soru Kitapçığı üzerinde herhangi bir işlem yapmayınız ve cevaplarınızı yalnızca cevap kağıdına yazınız. CEVAP KAĞIDINI doldururken dikkat edilecek hususlardan birisi, 1 den 8 e kadar olan sorularda her soru için cevap kağıdında iki kutu bulunmaktadır. Soldaki ilk kutuya sizce sorunun uygun cevap şikkını yazınız, ikinci kutucuğa yani AÇIKLAMASI yazılı kutucuğa ise o soruyla ilgili soru kitapçığındaki Açıklaması kısmındaki şıkları okuyarak sizce en uygun olanını seçiniz. Örneğin 12'nci sorunun cevabı sizce b ise ve Açıklaması kısmındaki en uygun açıklama ikinci şık ise cevap kağıdını aşağıdaki gibi doldurun:

12. AÇIKLAMASI

9. ve 10. soruları ise soru kitapçığında bu sorularla ilgili kısımları okurken nasıl cevaplayacağınızı daha iyi anlayacaksınız.

SORU 1: Bir boyacı, aynı büyüklükteki altı odayı boyamak için dört kutu boya kullandığına göre sekiz kutu boya ile yine aynı büyüklükte kaç oda boyayabilir?

- a. 7 oda
- b. 8 oda

- c. 9 oda
- d. 10 oda
- e. Hiçbiri

Açıklaması:

1. Oda sayısının boya kutusuna oranı daima $\frac{3}{2}$ olacaktır.
2. Daha fazla boya kutusu ile fark azalabilir.
3. Oda sayısı ile boya kutusu arasındaki fark her zaman iki olacaktır.
4. Dört kutu boya ile fark iki olduğuna göre, altı kutu boya ile fark yine iki olacaktır.
5. Ne kadar çok boyaya ihtiyaç olduğunu tahmin etmek mümkün değildir.

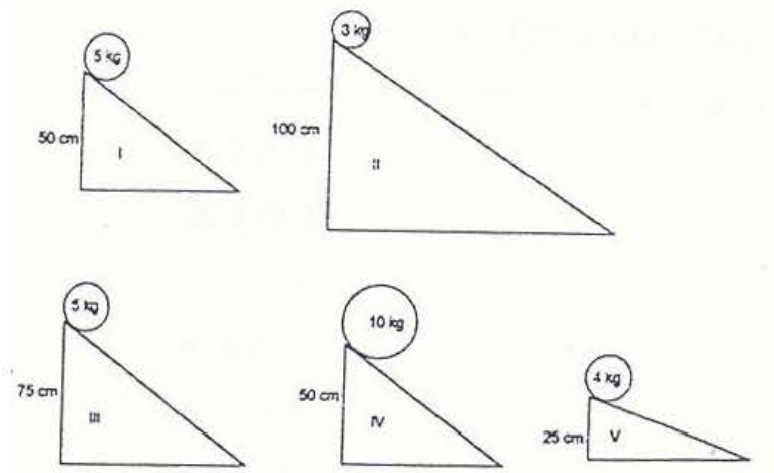
SORU 2: On bir odayı boyamak için kaç kutu boya gerekir? (Birinci soruya bakınız)

- a. 5 kutu
- b. 7 kutu
- c. 8 kutu
- d. 9 kutu
- e. Hiçbiri

Açıklaması:

1. Boya kutusu sayısının oda sayısına oranı daima $\frac{2}{3}$ dür.
2. Eğer beş oda daha olsaydı, üç kutu boya daha gerekecekti.
3. Oda sayısı ile boya kutusu arasındaki fark her zaman ikidir.
4. Boya kutusu sayısı oda sayısının yarısı olacaktır.
5. Boya miktarını tahmin etmek mümkün değildir.

SORU 3: Topun eğik bir düzlemden (rampa) aşağı yuvarlandıktan sonra kat ettiği mesafe ile eğik düzlemin yüksekliği arasındaki ilişkiyi bulmak için deney yapmak isterseniz, aşağıda gösterilen hangi eğik düzlem setlerini kullanırdınız?

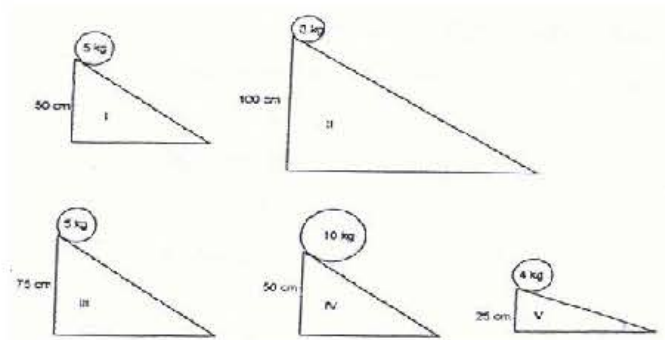


- a. I ve IV
- b. II ve IV
- c. I ve III
- d. II ve V
- e. Hepsi

Açıklaması:

1. En yüksek eğik düzlemle (rampa) karşı en alçak olan karşılaştırılmalıdır.
2. Tüm eğik düzlem setleri birbiriyle karşılaştırılmalıdır.
3. Yükseklik arttıkça topun ağırlığı azalmalıdır.
4. Yükseklikler aynı fakat top ağırlıkları farklı olmalıdır.
5. Yükseklikler farklı fakat top ağırlıkları aynı olmalıdır.

SORU 4: Tepeden yuvarlanan bir topun eğik düzlemde (rampa) aşağı yuvarlandıktan sonra kat ettiği mesafenin topun ağırlığıyla olan ilişkisini bulmak için bir deney yapmak isterseniz, aşağıda verilen hangi eğik düzlem setlerini kullanırdınız?



- a. I ve IV
- b. II ve IV
- c. I ve III
- d. II ve V
- e. Hepsi

Açıklaması:

- a. En ağır olan top en hafif olanla kıyaslanmalıdır.
- b. Tüm eğik düzlem setleri birbiriyle karşılaştırılmalıdır.
- c. Topun ağırlığı arttıkça, yükseklik azaltılmalıdır.
- d. Ağırlıklar farklı fakat yükseklikler aynı olmalıdır.
- e. Ağırlıklar aynı fakat yükseklikler farklı olmalıdır.

SORU 5: Bir Amerikalı turist Şark Expressi'nde altı kişinin bulunduğu bir kompartımana girer. Bu kişilerden üçü yalnızca İngilizce ve diğer üçü ise yalnızca Fransızca bilmektedir. Amerikalının kompartımana ilk girdiğinde İngilizce bilen biriyle konuşma olasılığı nedir?

- a. 2 de 1
- b. 3 de 1
- c. 4 de 1
- d. 6 da 1
- e. 6 da 4

Açıklaması:

1. Ardarda üç Fransızca bilen kişi çıkabildiği için dört seçim yapmak gerekir.
2. Mevcut altı kişi arasından İngilizce bilen bir kişi seçilmelidir.
3. Toplam üç İngilizce bilen kişiden sadece birinin seçilmesi yeterlidir.
4. Kompartımandakilerin yarısı İngilizce konuşur.
5. Altı kişi arasından, bir İngilizce bilen kişinin yanısıra, üç tanede Fransızca bilen kişi seçilebilir.

SORU 6: Üç altın, dört gümüş ve beş bakır para bir torbaya konulduktan sonra, dört altın, iki gümüş ve üç bakır yüzük de aynı torbaya konur. İlk denemede torbadan altın bir nesne çekme olasılığı nedir?

- a. 2 de 1
- b. 3 de 1
- c. 7 de 1
- d. 21 de 1
- e. Yukarıdakilerden hiçbiri

Açıklaması:

1. Altın, gümüş ve bakırdan yapılan nesnelere arasından bir altın nesne seçilmelidir.
2. Paraların $\frac{1}{4}$ ü ve yüzüklerin $\frac{4}{9}$ u altından yapılmıştır.
3. Torbadan çekilen nesnenin para ve yüzük olması önemli olmadığı için toplam 7 altın nesneden bir tanesinin seçilmesi yeterlidir.
4. Toplam yirmi bir nesneden bir altın nesne seçilmelidir.
5. Torbadaki 21 nesnenin 7 si altından yapılmıştır.

SORU 7: Altı yaşındaki Ahmet'in şeker almak için 50 lirası vardır. Bakkaldaki kapalı iki şeker kutusundan birinde 30 adet kırmızı ve 50 adet sarı renkte şeker bulunmaktadır. İkinci bir kutuda ise 20 adet kırmızı ve 30 adet sarı şeker vardır. Ahmet kırmızı şekerleri sevmektedir. Ahmet'in ikinci kutudan kırmızı şeker çekme olasılığı birinci kutuya göre daha fazla mıdır?

- a. Evet
- b. Hayır

Açıklaması:

1. Birinci kutuda 30, ikincisinde ise yalnızca 20 kırmızı şeker vardır.
2. Birinci kutuda 20 tane daha fazla sarı şeker, ikincisinde ise yalnızca 10 tane daha fazla sarı şeker vardır.
3. Birinci kutuda 50, ikincisinde ise yalnızca 30 sarı şeker vardır.
4. İkinci kutudaki kırmızı şekerlerin oranı daha fazladır.

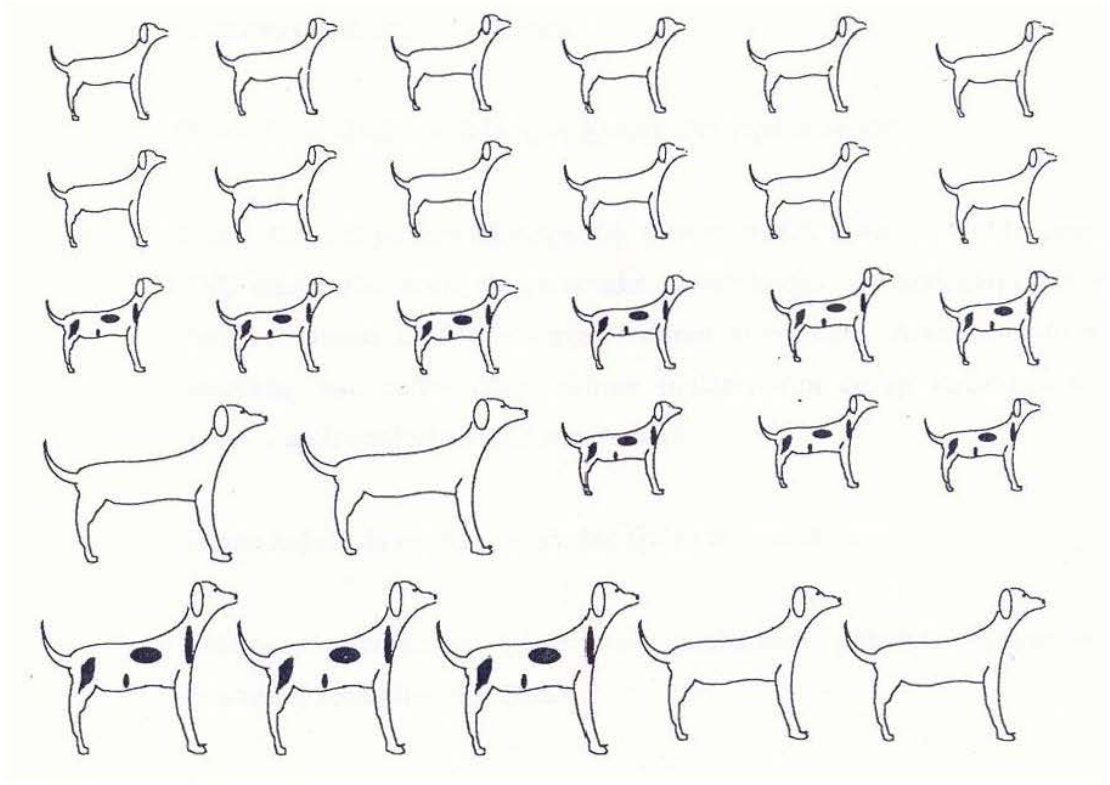
5. Birinci kutuda daha fazla sayıda şeker vardır.

SORU 8: 7 büyük ve 21 tane küçük köpek şekli aşağıda verilmiştir. Bazı köpekler benekli bazıları ise beneksizdir. Büyük köpeklerin benekli olma olasılıkları küçük köpeklerden daha fazla mıdır?

- a. Evet
- b. Hayır

Açıklaması:

1. Bazı küçük köpeklerin ve bazı büyük köpeklerin benekleri vardır.
2. Dokuz tane küçük köpeğin ve yalnızca üç tane büyük köpeğin benekleri vardır.
3. 28 köpektan 12 tanesi benekli ve geriye kalan 16 tanesi beneksizdir.
4. Büyük köpeklerin $\frac{3}{7}$ si ve küçük köpeklerin $\frac{9}{21}$ i benekli dir.
5. Küçük köpeklerden 12 sinin, fakat büyük köpeklerden ise sadece 4 ünün beneği yoktur.



SORU 9: Bir pastanede üç çeşit ekmek, üç çeşit et ve üç çeşit sos kullanılarak sandviçler yapılmaktadır.

Ekmek Çeşitleri

Buğday (B)

Çavdar (Ç)

Yulaf (Y)

Et Çeşitleri

Salam (S)

Piliç (P)

Hindi (H)

Sos Çeşitleri

Ketçap (K)

Mayonez (M)

Tereyağı (T)

Her bir sandviç ekmek, et ve sos içermektedir. Yalnızca bir ekmek çeşidi, bir et çeşidi kullanılarak kaç çeşit sandviç hazırlanabilir?

Cevap kağıdı üzerinde bu soruyla ilgili bırakılan boşluklara bütün olası sandviç çeşitlerinin listesini çıkarın.

Cevap kağıdında gereksiniminizden fazla yer bırakılmıştır.

Listeyi hazırlarken ekmek, et ve sos çeşitlerinin yukarıda gösterilen kısaltılmış sembollerini kullanınız.

Örnek: BSK= Buğday, Salam ve Ketçap dan yapılan sandviç

CEVAP 9:

SORU 10: Bir otomobil yarışında Dodge (D), Chevrolet (C), Ford (F) ve Mercedes (M) marka dört araba yarışmaktadır. Seyircilerden biri arabaların yarışı bitiriş sırasının DCFM olacağını tahmin etmektedir. Arabaların diğerk mümkün olan bütün yarışı bitirme sıralamalarını cevap kağıdında bu soruyla ilgili bırakılan boşlukalara yazınız.

Cevap kağıdında gereksiniminizden fazla yer bırakılmıştır.

Bitirme sıralamalarını gösterirken, arabaların yukarıda gösterilen kısaltılmış sembollerini kullanınız.

Örnek: DCFM yarışı sırasıyla önce Dodge'nin, sonra Chevrolet'in, sonra Ford'un ve en sonra Mercedes'in bitirdiğini gösterir.

CEVAP 10:

CEVAPLAR

1		
2		
3		
4		
5		
6		
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