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Developing a Mobile Application to Improve the Levels of Statistical Literacy among Graduate Students

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ABSTRACT

In today's world, educated individuals are expected to understand basic statistical concepts and interpret statistical messages. For this reason, despite the undeniable importance of statistical literacy in the educational process, studies on undergraduate and postgraduate students in practice reveal that students have difficulties in determining the data structure, choosing the appropriate test for the purpose, and interpreting the findings correctly. Similar studies indicate that steps should be taken in many ways to overcome such difficulties. When the respective literature is viewed, it is understood that the use of software packages in teaching has many disadvantages such as being complex, being expensive and not being compatible with mobile devices, therefore, tech-supported teaching materials suitable for the level of students, in other words, instructional software is needed. Hence, it was aimed in this study to design a mobile teaching software for the development of advanced statistical literacy skills, which are often needed in the scientific research process. For this purpose, the first type of development method, which is one of the quantitative research methods, was preferred in the research. At the end of the research process, a free mobile teaching software program was developed that can be used in the teaching of statistical concepts at the postgraduate level and can perform statistical analysis. The alternatives offered by the application developed as a result of the research in response to the needs in the literature were examined. Additionally, the application was published via Google Play Store and was made available for users for a period of one year to receive evaluations, and at the end of this period, it was downloaded by users from dozens of various countries. It has been observed that the application, which has been downloaded approximately 40 thousand times in the last six months and reached 16 thousand users, received 84.6% positive scores (4.23). It is estimated that the application, which was developed as a result of the process, will contribute to the literature in terms of statistical literacy.

Key words: Statistical Literacy**,** Teaching Software, Designing and Developing

INTRODUCTION

Today, with the importance of data, which is the source of scientific knowledge, in the age of information and communication, statistics education has become a strategic issue for countries to consider (Ben-Zvi, 2000; Tishkovskaya & Lancaster, 2012). So much so that in present-day, it is expected from educated individuals to understand the basic statistical concepts and to interpret statistical messages. In this context, the subject of statistics has been included in the curricula of many countries, especially in the last two decades, and the importance laid onto the subject is increasing (Akkoc & Yesildere-Imre, 2015; Guidelines for Assessment and Instruction in Statistics Education (GAISE, 2005); Koparan & Akinci, 2015; Yenilmez, 2016). When the purposes of statistics education are examined, it is aimed to improve statistical thinking and reasoning abilities in addition to obtaining statistical information in general (Batanero et al., 2011). In this context, it can be understood that cognitive objectives in statistical education are ought to be laid importance upon. These objectives are generally divided into three as statistical literacy, statistical reasoning and statistical thinking. Definitions of these terms according to Garfield and Ben-Zvi (2008) are as follows:

Statistical literacy: It is the ability to read and use basic statistical language and graphical displays to understand statistical information in daily life and media.

Statistical reasoning: It is to be able to keep in mind and relate different statistical concepts and ideas such as outliers, measures of central tendency and distribution.

Statistical thinking: It is a type of thinking that is used by statisticians when they encounter a statistical problem. This includes thinking about the type and quality of data, where the data came from, choosing appropriate analysis techniques, the experimental model, and interpreting the results in that context.

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In this context, the importance attached to statistics education and statistical literacy around the world increases with each passing day. Parallel to this, statistical literacy has become one of the most researched and emphasized studies in educational research (Ozmen & Baki, 2017). When the literature of statistical research is examined, many definitions can be found regarding this notion. Watson (1997) for instance, made a three-stage definition consisting of knowing basic concepts, understanding different concepts and statistical language, and approaching these concepts critically. Gal (2002), on the other hand, defined statistical literacy as individuals' ability to discuss statistical situations, interpret random events, make critical assessments and state opinions regarding these. Ozmen and Baki (2017) stated that statistically literate individuals are ought to adopt statistical language and terminology, and it is important for them to derive meanings for concepts.

Despite the undeniable importance of statistical literacy in the educational process, it is seen that there are various difficulties in teaching statistics in practice (Ben-Zvi & Garfield, 2004; Çakmak & Durmuş, 2015; Kaynar & Halat, 2012; Koparan & Güven, 2013; Zawojewski & Heckman, 1997).

When studies at secondary and primary education levels are examined, it is seen that most of the students have low success levels in organizing and representing data, showing data, data analysis, and data interpretation (Koparan & Guven, 2013), and students have difficulty in interpreting the central tendency and dispersion measures in the curriculum (Cakmak & Durmus, 2015), especially the arithmetic mean (Watson & Moritz, 2000) and standard deviation (Akkoc & Yesildere-Imre, 2015). In addition, there are difficulties such as interpreting different standard deviations in data with the same mean (Dubinsky & McDonald, 2001). On the other hand, statistical thinking or statistical reasoning is one of the most difficult subjects for students (Onwuegbuzie, 1997). Statistical reasoning can be defined as making sense of statistical information, displaying data sets graphically, and interpreting statistical results (Garfield, 2002).

On the other hand, many difficulties were encountered especially in studies aimed at university students (Akkoc & Yesildere-Imre, 2015). According to these studies, students who take basic statistics courses in undergraduate and postgraduate programs often experience statistics anxiety (Williams, 2010). This anxiety refers to the state of anxiety that arises while taking a statistics course or performing statistical operations such as collecting data, analyzing data, and interpreting analysis outputs (Cruise et al., 1985; Onwuegbuzie et al., 1997). Moreover, it has been reported that approximately 80% of the students continuing their postgraduate education experience this anxiety (Onwuegbuzie, 2004). If these deficiencies are not eliminated, the deficiencies of the students will remain when they become teacher candidates (Cooper, 2002).

On the other hand, it is known that postgraduate students often do not have knowledge or have a lack of information about which statistical technique to use under what circumstances in scientific research. Therefore, the main difficulties that are aimed to be solved within the scope of this study and encountered in the literature can be listed as follows;

- Ignoring the structure of the distribution of the data (Kabaca & Erdogan, 2007),
- Not knowing non-parametric statistical techniques (Simsek et al. 2009),
- Ignoring the purpose of the test (Akkus et al., 2006),
- Using tests that serve different purposes (Toy & Tosunoglu, 2007),
- Misinterpretation of the findings (Erdogan, 2001),
- Failure to use methods suitable for data (Kim & Lee, 2019),
- Incorrect evaluation according to the p value at the limit values (Habibzadeh, 2013).

Due to these difficulties, some mistakes are made in scientific studies (Toy & Tosunoglu, 2007). Similarly, since the correct interpretation of the results of a study primarily depends on the selection of the statistical test suitable for the purpose and the data, the analysis of the data obtained at the end of the study is seen as a rather complex problem not only for postgraduate students but also for all researchers (Kul, 2014). However, since these problems start at the postgraduate level where the postgraduate student takes the first steps in understanding the articles, analyzing and interpreting the data, they arise in courses such as statistics (Fitzgerald et al., 1996; Onwuegbuzie & Seaman, 1995) and research methods (Onwuegbuzie et al., 2000) that affect the writing of the thesis.

Likewise, according to Kabaca and Erdogan (2007), it has been observed that in many postgraduate thesis studies, the data situation is generally not taken into account in the analysis and there are mistakes and deficiencies in the selection of methods at many stages. Evrekli et al. (2011) also stated that there are deficiencies in the selection of statistical techniques in many theses, especially in the field of science education. To avoid these situations, every researcher has to have a sufficient amount of statistical knowledge to be able to carry out their research (Toy & Tosunoglu, 2007). When examining the basis of all these problems that also exist in the literature, it is seen that it is generally caused by the emphasis on the mathematical and technical aspects of statistical information and the lack of use of statistical information at the required level (Allen et al., 2010; Garfield, 1995).

On the other hand, plenty of methods are utilized so that such difficulties in teaching statistics can be overcome. Tech-supported teaching is the primary method among these methods (Akkoc & Yesildere-Imre, 2015; Chance et al., 2007; Dogan, 2010; Koparan, 2015; Schuyten et al., 1999). Based on this method, independent software that is easy for students to use were developed to solve the problems in teaching (Holton & Artigue, 2001; Bilgin 2018). Generally, such applications (software) that are used for teaching purposes are called teaching software and they are developed independently over any subject (Akkoyunlu, 2005).

The first of these developed teaching software programs is the application developed by Grubb and Selfridge in 1964 (Dogan, 2010). Similar software was developed for the probability unit by Donald Henry McClain in his doctoral thesis (McClain, 1970). Throughout the time, many software programs have been developed, an online environment was developed by Emmungil and Geban in 2010 (Emmugil & Geban, 2010) as an example, and another NSistatistik software program was developed by Bilgin in 2014 (Bilgin, 2018). In the present day, software programs such as Tinkerplots, VUstat, Fathom are used in teaching statistics. However, one of the most important issues to be considered is that the software developed should be specially designed in relation to the level of students (Bakker, 2004). Therefore, it is seen that there is a need for tech-supported teaching materials related to the subject, in other words, teaching software (Akkoc & Yesildere-Imre, 2015). Hence, it is understood that an application should be developed for teaching statistics for postgraduate students. In this context, it is thought that designing an application to teach commonly used concepts such as test names, test parameters, significance levels, effect sizes, which are frequently used in academic studies, in the context of statistical literacy will contribute to the literature.

PURPOSE

In this study, it was aimed to design a mobile teaching software program for the development of statistical literacy levels related to advanced statistical information, which includes concepts that are frequently involved in the scientific research process, such as parametric and non-parametric analysis methods, significance level, and p-value, beyond basic statistical concepts.

The Significance and Motive of the Research

It is a known fact that statistics has a crucial spot in terms of science. Moreover, as it is an essential tool for other scientific disciplines, it is taught in different dimensions even during the undergraduate periods (Koparan, 2012). On the other hand, statistical literacy and statistical knowledge are of critical importance especially for postgraduate students due to mistakes made in scientific studies. Therefore, to improve statistical literacy and contribute to the literature, many independent software programs are developed (Holton & Artigue, 2001). Thanks to these programs, students can learn subjects through various interactions. However, such applications are mostly used at the secondary school level, and at the postgraduate level, they use computer algebra systems such as SPSS, SASS, Mathematica, Matlab, SciLab and APSS (Dogan, 2010; Holton & Artigue, 2001). Another important point is that since it is known that the use of complex software packages has disadvantages, it is known that the most important criterion in the selection of the tool to be used by educators should be easy to use (Chance at al., 2007). Also, it can be said that they have very limited use because these software programs must be purchased and the installation processes make it harder for students. Therefore, the realization of such a development study for statistical literacy and statistics teaching is of great importance in terms of its potential contributions such as performing statistical operations on mobile devices, being free of charge, being away from the complexity of package programs, and teaching purposes.

METHOD

In this section, explanations about the research method, design of the software and development process were given.

Research Design

The main purpose of this research is to develop a mobile teaching software program that can be used by teaching statistical concepts during the scientific research process. In accordance with this purpose, the research model called Design and Development Research (DDR) was preferred. A new product or tool is being developed according to this model (Buyukozturk et al., 2018). In addition, it is necessary to test the developed product based on different aspects and to demonstrate its applicability, effectiveness, and efficiency (R. Richey & Klein, 2008; R. C. Richey & Klein, 2014). Richey and Klein (2008) state that quantitative or qualitative methods can be used in design and development research, as well as both approaches, can be used together. In this study, quantitative data such as percentage and frequency were used.

On the other hand, many different instructional design models such as Dick and Carey, Kemp, Transactional Distance, Rapid Prototyping, and 4C instructional design are used in development research (Buyukozturk et al., 2018; Esmer, 2018). It is possible to see the stages in the ADDIE approach in almost all of these different models, so Richey and Klein (2014) stated that the stages of the ADDIE model, which are the stages of analysis, design, development, implementation, and evaluation, are reported as the stages of DDR research. In this context, the stages of the research are presented in Figure 1.

Analysis

The deficiencies, needs, and new and advantageous techniques for teaching statistics were determined by examining the existing literature. In general, in the light of this information presented in the introduction part of the article, it is seen that there is a need for technology-supported instructional software. When the environments in which the teaching

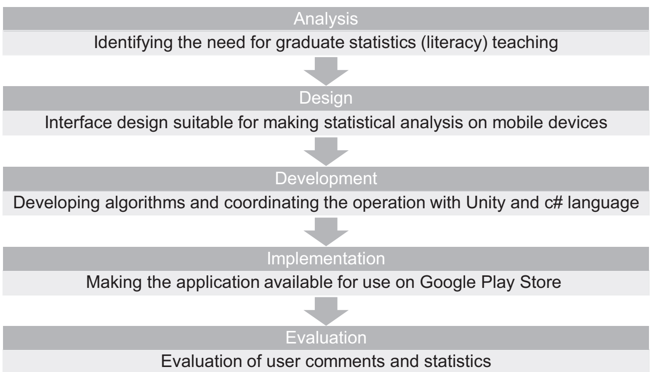


Figure 1. Design process

software to be developed are examined, it is seen that mobile learning (Lee et al., 2018) comes first among the most up-to-date tools used in teaching. Thanks to the effective use of mobile devices, active participation of students in the lesson and effective course flow can be ensured (Karaarslan et al., 2013). Mobile learning offers many more educational opportunities. For example, in mobile learning, there is no space restriction (Kukulska-Hulme, 2009) and it is a student-centered approach that provides the opportunity to learn at any time and place (O'Malley et al., 2005). However, it has been determined that software used in statistics education such as Tinkerplots, VUstat, and Fathom are not compatible with mobile devices. Similarly, the fact that package programs such as SPSS, SAS, and R cannot be used on mobile devices makes this software deficiency even more evident. In addition, it is known that the software used in the course should be developed for the curriculum used by the students (Avci & Coskuntuncel, 2019). Similarly, the applications to be developed should be suitable for the students' own spoken language (for example, English) (Akkoc & Selcuk, 2017) and should be offered free of charge to students (Avci & Coskuntuncel, 2019).

In this context, it is understood that a mobile teaching software that can be used in the teaching of advanced statistical information such as the tests used in the scientific research process, the data structure, and the concepts in the test results should be developed.

Design

Since it is known that the use of complex software packages in statistics teaching for students is of great disadvantages, the tool to be utilized should be easy to use for educators (Chance at al., 2007). Therefore, unlike the package programs, an application was designed as direct instruction.

In the general interface in Figure 2, basic tools are placed on the vertical screen, which is described as the Portrait position. Numbers on the figure refer to buttons and messages where different operations are performed. The analysis method to be performed is selected from section number (1) in Figure 2. 16 different statistical analyses and plenty of mathematical operations can be performed within the application. These analyses are shown in Figure 4 and Figure 5. The data from section (2) in Figure 2 can be saved and stored in the device memory so that it can be accessed later. New variables can be added to the data set from section (3). For example in Figure 2, two variables namely "girls" and "boys" were added. In section (4) in Figure 2, the significance level, which serves as the critical value in the interpretation of the analyses, is selected. In section (5), the selection of the variable to be included in the analysis is made. For example, in Figure 2, the variable named "girls" was selected and the analysis was made over this variable. Observations corresponding to the relevant variable in section (6) are entered with a space between them. In section (7), the names of the variables are determined. Section (8) contains the results of the analyses, and section (9) contains the list of variables selected to be included in the analysis. Lastly, section (10) is used for the implementation of the selected analysis.

The analysis method to be performed is selected from section (1) in Figure 3. Information about the variable used is presented afterwards. Section (2) contains the results of

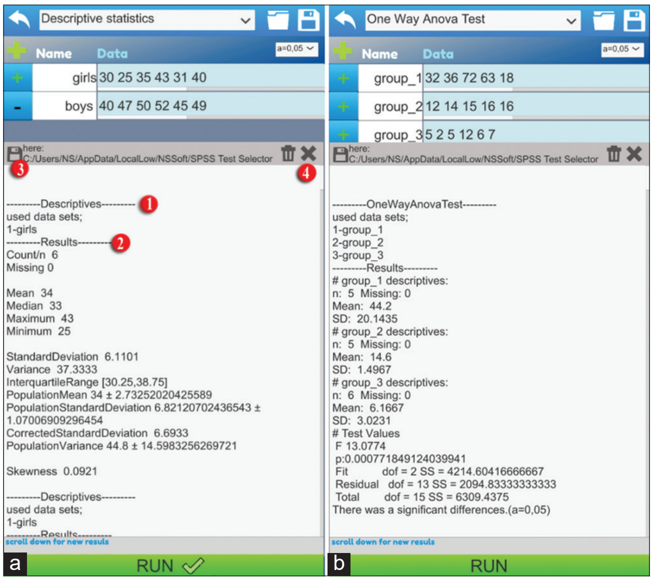


Figure 3. (a) Conclusion screen 1. (b) Conclusion screen 2

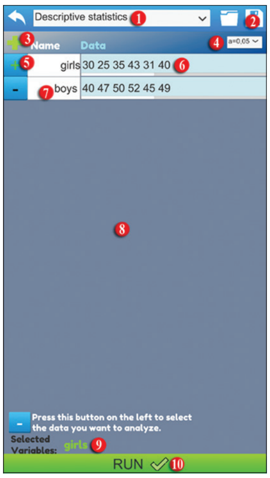


Figure 2. Main interface

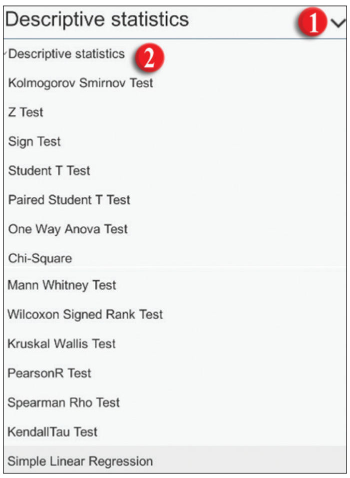


Figure 4. Usable analyses

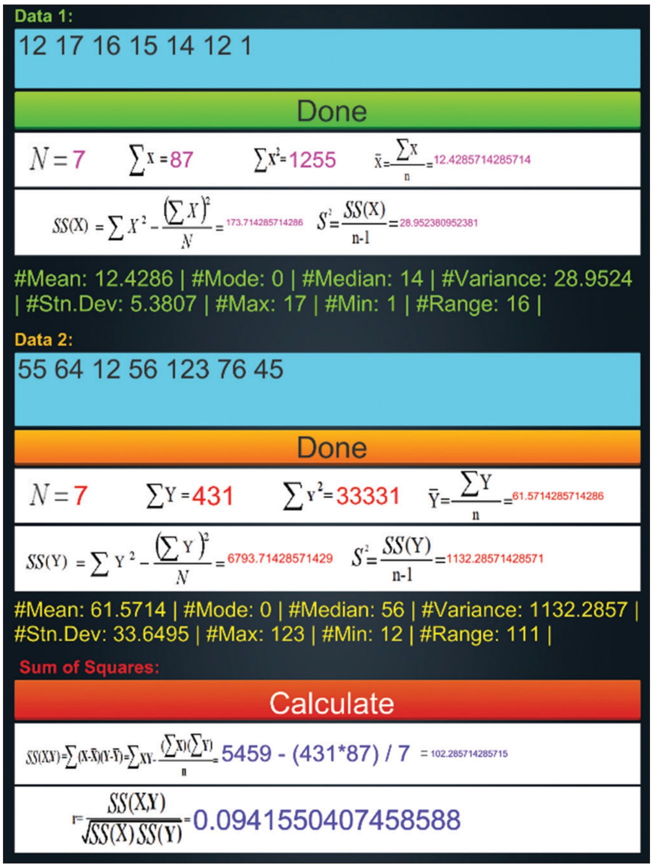


Figure 5. Sum of products calculator

the analysis. The results in Figure 3 are the results of descriptive statistics. This section includes the reports prepared in accordance with the content of the test when the other analyses in Figure 4 and Figure 5 are selected. In section (3) in Figure 3, the report can be saved to the device as a text document. The report screen can be cleared or closed through section (4).

All statistical tests and calculations in the application are shown in Figure 4 and Figure 5. After the user data entry is made, all statistical methods can be viewed. On the other hand, variables should be selected relative to the analysis method. Otherwise, an error report cannot be received. For example, two variables required for the implementation of the Independent Samples T-Test, which includes two different numerical data sets, must be selected and displayed in section (9) in Figure 2. Directions about the use and operation of the application are presented to the user at the first login to the application. It is also possible to access this directive at any time. The flow chart of the application is presented in Figure 6.

Development

Unity program and C# language were used in the development phase of the application. In this context, various algorithms have been developed to prepare the functions in the design section. In addition, Meta.Numerics library with an MS-PL license was used in the study. During the development process, separate functions were created

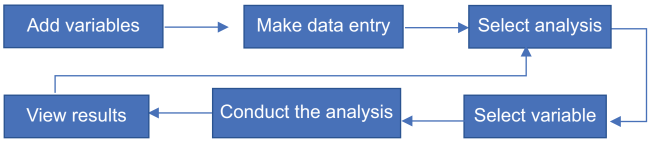


Figure 6. Application flow chart

for 16 different statistical tests and data entry, variable selection, logging data of results and opening logs. The algorithm prepared for Descriptive Statistics is shown in Figure 7. Similar algorithms were prepared for other analyses.

When the algorithm shown in Figure 7 is examined, it is seen that the minimum number of variables required for the selected data set and the selected analysis method was controlled. If it is different from the required number as a result of the control, an error message is sent to the user. After the required number of data is confirmed, the variable preferred by the user is transferred to the temporary variable named "a" and the necessary calculations are made. The result is presented to the user afterwards.

Implementation

According to Buyukozturk et al. (2018), at this stage of the ADDIE model, the product is actually used for its intended purpose, and in this process, data on the product's impact and efficiency are collected. In this context, the application was made available for use on Google Play Store and remained so for a period of one year. A transition was made to the evaluation process over the user and discount rates gathered from this process.

Evaluation

According to Buyukozturk et al. (2018), in the evaluation process, the overall impact of the conducted research, its contribution, strengths and aspects to be improved have to be revealed in the light of the data gathered about the application. Therefore, this stage of the development process is provided in the findings section.

FINDINGS

In this part of the research, it was aimed to discuss the product and evaluate the findings obtained after its usage. In this context, download reports from Google Play Store were examined in the findings part to acquire information about subjects such as whether the developed application is useful in terms of software or whether it can serve the purpose. When the 180-day report in Figure 8 was examined, it was found out that the number of devices in which the application was actively installed was 16.817.

When the increase in the number of users is examined, it is seen that the application has attracted a large number of users. There has been an increase of 35% in the last six months compared to the previous period. On the other hand, when the download numbers are inspected, it is seen that the application had 240 new downloads daily.

```
int req =1;
if(ad.Count== req)
{
Sample a =new Sample(veri_hizli(data[0]));
results.text+=Environment.NewLine;
string testadi="Descriptives";
results.text+=Environment.NewLine+"---------"+testname+"---------";
results.text+=Environment.NewLine+"used data sets;";
for (int i = 0; i < ad.Count; i++)
{int kk=i+1;
results.text+=Environment.NewLine+kk+"-"+ad[i];}
results.text+= Environment.NewLine+"---------Results---------";
results.text+= round("Count/n ",a.Count);
results.text+= "Missing "+ missing_hizli(data[0]).Count.ToString();
results.text+= round("Mean ",a.Mean());
results.text+= round("Median ",a.Median);
results.text+= round("Maximum ",a.Maximum);
results.text+= round("Minimum ",a.Minimum);
results.text+= round("StandardDeviation ",a.StandardDeviation());
results.text+= round("Variance ",a.Variance());
results.text+= "InterquartileRange "+a.InterquartileRange.ToString();
results.text+= "PopulationMean "+a.PopulationMean.ToString();
results.text+= "PopulationStandardDeviation "+a.PopulationStandardDeviation.ToString();
results.text+= round("CorrectedStandardDeviation ",a.CorrectedStandardDeviation());
results.text+= "PopulationVariance "+a.PopulationVariance.ToString();
results.text+= round("Skewness ",a.Skewness());}
else
{results.text+=Environment.NewLine+"#you must select "+ req +" data set for this test!";
}}
```

Figure 7. Descriptives

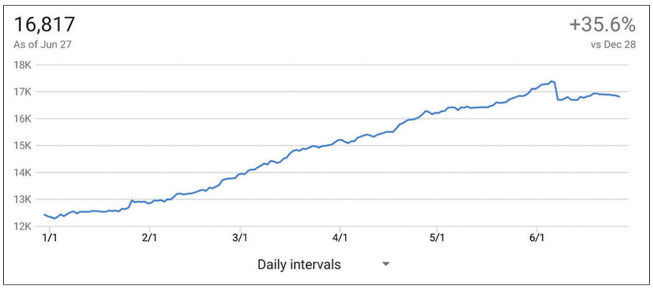


Figure 8. Active Users

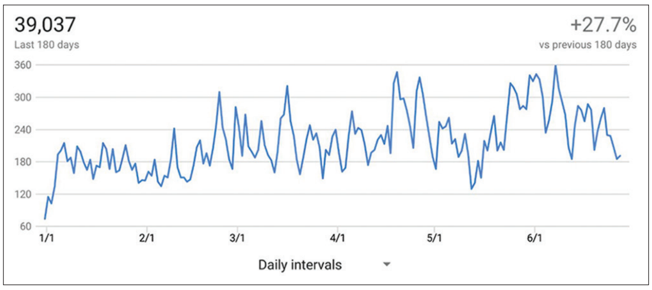
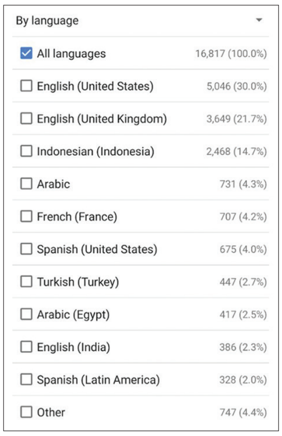


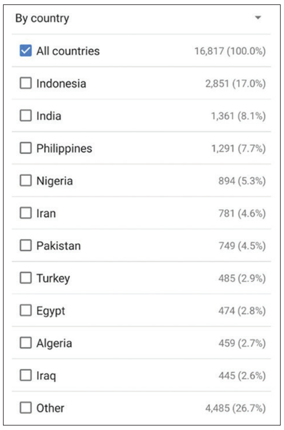
Figure 9. Daily Downloads



By language

All languages	16,817 (100.0%)
English (United States)	5,046 (30.0%)
English (United Kingdom)	3,649 (21.7%)
Indonesian (Indonesia)	2,468 (14.7%)
Arabic	731 (4.3%)
French (France)	707 (4.2%)
Spanish (United States)	675 (4.0%)
Turkish (Turkey)	447 (2.7%)
Arabic (Egypt)	417 (2.5%)
English (India)	386 (2.3%)
Spanish (Latin America)	328 (2.0%)
Other	747 (4.4%)

Figure 10. Languages



By country

All countries	16,817 (100.0%)
Indonesia	2,851 (17.0%)
India	1,361 (8.1%)
Philippines	1,291 (7.7%)
Nigeria	894 (5.3%)
Iran	781 (4.6%)
Pakistan	749 (4.5%)
Turkey	485 (2.9%)
Egypt	474 (2.8%)
Algeria	459 (2.7%)
Iraq	445 (2.6%)
Other	4,485 (26.7%)

Figure 11. Country

Another important criterion in the examination of the application was the rating it received from the users. The overall rating of the application was found to be 4.23. Hence, it can be said that 84.6% of the users were content with the product.

The languages and countries where the application is used the most are presented in Figure 10 and Figure 11.

When the languages are examined, it is seen that 51.7% of the devices the application were used on had English as the language of the device. Devices with Indonesian comes second with a rate of 14.7%. Then it is seen that it is used on devices with Arabic at a percentage of 4.3%, French at a percentage of 4.2% and Spanish at a percentage of 4%. In terms of countries, 17% of the users were from Indonesia, 8.1% from India and 7.7% from the Philippines. In addition,

Figure 12. Users Feedbacks

some users' comments on the application are presented in Figure 12.

The feedback from the users is that the application is generally found useful. In addition, no suggestions were made by the users for the operation of the application.

CONCLUSION

It is aimed in this research to design a mobile teaching software program for the improvement of statistical literacy, which is one of the most important cognitive processes of teaching statistics. When the literature regarding statistical literacy is reviewed, it comes to the fore that the use of technology in teaching statistics is necessary. For example, computers make it possible to use data, which is difficult to enter manually, by using various methods and to carry out multi-dimensional research (Koparan & Akinci, 2015). Similarly, it was provided that the application has the same feature. So that users can use the data sets they created, again and again, experiencing various analyses. In particular, the fact that variables are selected in different numbers and parametric and non-parametric tests are applied to these variables helps users by the test determination and the assumptions of the tests, thus making it possible to conduct multi-dimensional research.

On the other hand, according to NCTM (2000), while creating a technology-based learning environment, its contribution to the content of the curriculum should be considered. It is also recommended to consider increasing interest in conceptual understanding, connections between multiple representations, mathematical modeling, aspects of problem-solving, and real-world applications. When the application is evaluated, it is clear that it will contribute to the skills of postgraduate students such as conceptual understanding of descriptive and inferential statistics and making connections between concepts, especially in quantitative data analysis courses. For example, the student will be able to comprehend that the analysis methods that can be made for a data set consisting of a single group and the tests in which the two groups are obtained by using different methods. Similarly, it will be possible through experimenting to find out what effect the concept of significance level can have on all test results, where there are similar values/parameters. In addition, it will be possible to observe the subjects that require advanced statistical thinking skills from different perspectives, such as how the logic is followed in the interpretation of the p-value. It is thought that this situation may contribute to the elimination of method errors used in scientific studies. For instance, it is known that wrong statistical methods are used as a result of not considering the data situation within analyses (Evrekli et al., 2011). In this context, inaccuracies and deficiencies in the selection of parametric and non-parametric tests can reduce the reliability level of research. For example, Kabaca and Erdogan (2007) came across similar errors in postgraduate theses.

Again, in the literature, it is stated that as a result of the use of dynamic statistics software in the courses in which statistics are taught, data and findings can be generated quickly and more emphasis can be placed on discussion, estimation and inferences. Therefore, it will be possible to present the results of some changes in the data effectively through applications (Koparan & Akinci, 2015). This similarly developed application includes said features. For example, it can be examined how each change in the data instantly leads to results, and how an extreme value in the data set affects the central tendency and spread measures can be observed practically. Additionally, examples can be solved of the effects of these values on the analysis results. On the other hand, reflections of extreme values in parametric and non-parametric tests can be observed.

One of the problems encountered in teaching statistics is that there are no alternative approaches used in the evaluation of students and traditional assessment techniques do not provide valid and reliable measurements on important student abilities such as statistical reasoning (Gal & Garfield, 1997; Garfield, 1994; Garfield & Gal, 1999). In this context, with the help of the application, an effective and versatile evaluation method can be used by giving various data sets to students, thus determining the appropriate analysis method and obtaining the result. Therefore, the product is thought to be a good alternative for evaluating students.

The use of real data and the use of active learning methods in the classroom (Tishkovskaya & Lancaster, 2012) are of great importance in terms of teaching statistics. The use of real data, data analysis and the use of technology to improve conceptual understanding is recommended by the widely used GAISE report (Franklin et al., 2007; GAISE, 2005). In this context, it is important that students work with real data so that it allows them to put the things they have learned into practice. Students make extra effort to understand and explain the data when they work with the data they gathered and not the data others gathered (Koparan & Akinci, 2015). Therefore, it is apparent that it will be very beneficial for them to gather their own data by using advantages of the mobile devices. It is thought that the ability of the developed application to perform statistical analysis on mobile devices can provide great benefits, especially due to its advantages such as being able to easily make data entries via smartphones, saving and using data later.

It is suggested for students to use methods that put them in the center and are active in statistics teaching

(Tishkovskaya & Lancaster, 2012). The application is thought to be a teaching software program that is based on a configurative theory where it similarly provides students to actively learn by doing and experiencing. Therefore, it enables students to learn statistical concepts thoroughly. In addition, various tools that can help conceptual understanding, as well as procedural knowledge, are included in the application by easily performing the main basic mathematical operations such as the sum of squares and multiplication of squares, which are frequently used in statistics teaching.

According to Koparan and Akinci (2015), software programs ought to be used in classes and as teaching tools in teaching statistics. The tool developed in this context does not have any features that would prevent its use in the classroom. For example, many actions can be done about subjects such as data, variables, central tendency and diffusion measures, parametric methods, non-parametric methods without any obligations such as logging in, internet access, paid content etc. In addition, calculations such as the sum of squares, which are frequently used in statistics teaching, are also included in the application.

The application reported as a result of this research, in which the requirements specified in the literature are tried to be met in many respects, facilitates the mathematical-operational steps used in learning the statistical concept to achieve important cognitive goals such as statistical literacy and statistical reasoning on mobile devices in general. Thus, it is thought that the application helps by teaching statistical concepts that are planned to be taught at the postgraduate level. With this product, users can easily access these processes that can be carried out through package programs under regular circumstances. When the application is examined in terms of statistical literacy, it will help to teach concepts such as “arithmetic mean” and “variance”, which are frequently used in daily life, as well as scientific literature concepts such as “significant difference”, “independent samples t-test” and “ANOVA”, which are widely used at the postgraduate level. On the other hand, considering the download rates and active user numbers in the findings section, it can be said that it has achieved quite a high level of success, considering that it is such an application that provides content for purely academic purposes.

Although the application meets many needs stated in the literature, it has some shortcomings as well. The main one is graph drawing. Improvements can be made to enable students to gain skills such as graphic interpretation, which are included in statistical literacy. Also, comparison methods can be adapted to measure the effectiveness of the application. On the other hand, an interface can be added to help test determination by using test selection algorithms. The application can be supported by sharing the missing aspects of the application by the users and educators and the parts that can contribute to its development with the researcher.

ENDNOTE

1. The application developed in this study can be accessed at: https://play.google.com/store/apps/details?id=com.NSSoft.SPSSTestSelector

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