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Evaluating the Practices of Instructors Teaching Statistics Courses from Different Undergraduate Programs in Terms of Statistical Literacy *

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Abstract

In this study it was aimed to evaluate the practices of instructors teaching statistics courses in different undergraduate programs in terms of statistical literacy. Through this aim, statistics courses of nine instructors from nine different undergraduate programs were observed during a semester in a state university. Qualitative data of this study consisted of classroom observations, field notes and interviews conducting with instructors. Data was analyzed with the rubric, including the aspects of the statistical literacy components to evaluate statistical literacy practices. Chi-Square independent test was performed to determine whether the differences between programs are statistically significant. Differences were seen between programs and components the practices of instructors in statistics courses. In their practices, instructors mostly referred to basic concepts component and they referred to statistical process component at least. As a result of Chi-Square analysis it was seen that all of differences based on statistics practices between components and aspects according to programs were statistically significant. And key aspects were identified for statistical literacy based on the practices of statistics courses. Important steps would be taken to raise undergraduate students' statistical literacy levels if these aspects are taken into consideration at determining the course context and designing the practices.

Keywords

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Introduction

Statistics that requires to organizing and interpreting data and inferring from numerical data for problem situations, permeates our lives and sorts out many sciences including mathematics is one of the important subjects of mathematics education. In literature, the importance and role of statistics upon our lives is frequently emphasized (Ben-Zvi & Garfield, 2008; Guidelines Assessment in Statistic Education [GAISE], 2005, 2006; Schield, 2008). In GAISE (2005) report it was stated that our lives are surrounded with quantitative and qualitative contexts. And it was suggested that "every high-school graduate should be equipped with statistical literacy to cope with the requirements of citizenship and

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to be prepared for a healthy, happy, and productive life" (p. 1). Ben-Zvi and Garfield (2008) stressed that when it was compared with the past, statistics instruction included more students from different educational levels and researchers, educators, adults started to draw attention to statistics mostly. As a result of the importance of statistics and emphasis about the necessity of the statistics education, individuals are expected to be aware and interpret the situations about their lives, and to be statistically equipped and statistically literate (GAISE, 2005; Mittag, 2010). In this sense, statistical literacy, having a decisive role on daily life choices, preferences at supermarkets, decisions in our health, every field from media to politics (GAISE, 2005) is among the important areas of mathematics education too.

Statistical Literacy

As statistics has a wide work area in mathematics education in recent years, statistical literacy emerges as a subject being mostly investigated and mostly stated about its' importance (Mittag, 2010; Watson, 2006; Watson & Callingham, 2004). Although statistical literacy is seen one of the important learning outcomes for the statistics field by many researchers (delMas, 2002; Garfield & Ben-Zvi, 2008; Garfield & delMas, 2010), it is underlined that statistical literacy has any widely accepted definition and extent yet (Murray & Gal, 2002; Whetstone, 2014). Therefore there are many definitions based on different aspects of statistical literacy. Wallman (1993) defined statistical literacy as "an ability to understand and critically evaluate statistical results that permeate daily life, coupled with the ability to appreciate the contributions that statistical thinking can make in public and private, professional and personal decisions" (p. 1). Garfield (1999) emphasized 3 points in his statistical literacy definition (as cited in Rumsey, 2002):

1) Understanding statistics language: words, symbols, and terms;
2) Being able to interpret graphs and tables;
3) Read, interpret and make sense of different contexts in the news, media and daily lives.

Gal (2002) defined statistical literacy as an ability of discussing about statistical information or interpreting the possible situations, evaluating critically, and expressing their opinions; with this definition he drew attention to the fact that statistical literacy required critical stance and interpreting skills.. Hovermill, Beaudrie, and Boschmans (2014) stressed the importance of the understanding of statistics within the relevant for statistical literacy. In GAISE (2006) report statistical literacy defined as to know what statistical terms and symbols mean, to understand the basic language or fundamental ideas of statistics, to be able to interpret statistical graphs. From these definitions; we could define statistical literacy to interpret table and graphs, to infer from data, to make effective decisions, to critically evaluate, to know the basic language of statistics, to adopt the terminology of statistics, and to interpret the relevant contexts.

In GAISE (2005) report, it was noted that statistical literacy is essential for personal lives and important for our daily personal choices, and also it provides us to make decision about the quality of foods and their effect on our shopping in this direction. Also Ramirez, Schau, and Emmioğlu (2012) noted that raising statistical literate individuals should be an ultimate goal of statistics education. Chick and Pierce (2012) stressed that statistical literacy is a basic requirement to raise students as being able to make sense of data and to take efficient decisions related daily life situations. Wallman (1993) emphasized promoting the statistical literacy level for all citizens whatever their level of education in the nineties and stressed that one of the aim of the teachers in elementary and secondary schools to raising their students as statistical literate. Mittag (2010) stressed the importance of statistical literacy as a key qualification for employers and policy makers in educational institutions and remarked on promoting it. Biggeri and Zuliani (1999) pointed out that statistical literacy is an essential for democratic life and has an important role on keeping pace with in the age of information and computers in real sense and making decision on daily life situations independently and effectively. Packer (1997) stressed the increasing need for statistical literate people in many workplaces, and the importance of understanding statistical information through these needs for workers to promote quality of processes. In GAISE (2005) report; statistical literacy is called as an ultimate goal. Also this goal is explained in report with the idea that "people are surrounded with statistical information on topics ranging from the economy to education, from movies to sports, from food to medicine, and from public opinion to social behavior in either newspaper or other media reports" (p. 1). Also it is stressed that individuals could cope with statistical information at work, and teachers may engage in statistics concerning their students' performance or own responsibilities. Therefore report points out the importance of statistical knowledge on many disciplines as understanding and making sense of statistical results such experiments as testing the drugs in medical sciences or determining crime statistics and getting results in law enforcement field (GAISE, 2005). So the importance of statistics and its' surrounding our lives is understood. Since job groups are differed, it is seen that statistical literacy is an essential quality to maintain more successful and productive professional lives. At this point, as future individuals, for undergraduate students the importance of being statistical literate is arisen. And the question that "to what extent statistics courses contribute to this aim" is revealed.

Ben-Zvi and Garfield (2004) stressed to focus more on statistical literacy, reasoning, and thinking rather than teaching based on skills, procedures, and computations in statistics courses. Chance (2002) noted that statistics courses should aim to teach individuals through "what is needed for an informed consumer of statistical information". Rumsey (2002) stated that "any introductory statistics course should raise students' awareness of real life data and prepare them for a career for information age in today". Hassad (2007) referred to give a place on concepts and their applications rather than calculations, procedures and rules as underlining the importance of reform-based (concepts based) teaching of statistics to develop statistical literacy. Reston (2005) suggested that challenges emerging in the statistics courses should be overcome by incorporating statistical literacy in the statistics courses contents in undergraduate education and studies should be carried out in this way considering the multidimensional and dynamic nature of statistical literacy. Parallel with these emphasizes, the importance of inquiring to what extent statistics courses focused on statistical literacy in statistics courses practices is emerged.

Undergraduate education is an important stage for individuals to embark on life and to be successful at their works in the future. In this stage, education related students' professions are given through course contents which specific for faculties and their departments, practices about the professions, total credits, theoretical, laboratory, and practice lessons. The aim is raising individuals as equipped with requirements of their professions. Lessons and the content of these lessons are differed depending on students' professions. However work groups are different, statistics is emerged as one of the common lesson in undergraduate programs. For statistics being a common lesson at undergraduate programs indicates that statistical knowledge is a common requirement for professional lives of individuals. Considering the importance of being statistical literate individuals, determining to what extent practices in statistics courses contents focus on statistical literacy is important. Also subjects and information in statistics courses may vary in different profession groups. And this situation reveals the question as "What kind of practices related statistical literacy take part in statistics courses in profession groups?". Also in which aspects practices are being differed or similar is gained importance. Thus it would be seen that how statistics course practices change depending on professions as revealing different and similar aspects of profession groups in terms of statistical literacy.

Purpose of the Study

The purpose of this study is to evaluate the practices of instructors who teach statistics courses in different undergraduate programs in terms of statistical literacy. From this perspective, the following research questions and sub-questions were asked within the scope of relevant purpose:

1. How instructors' practices of statistics courses differ in terms of statistical literacy in different undergraduate programs?
    1.1. How the practices differ in terms of the statistical process component?
    1.2. How the practices differ in terms of the reasoning component?
    1.3. How the practices differ in terms of the basic concepts component?
    1.4. How the practices differ in terms of the context component?

Theoretical Framework

Statistical literacy models were developed to evaluate statistical literacy in a wider framework and to approach statistical literacy theoretically. When we analyzed statistical literacy models in the literature (Gal, 2002; Watson, 1997, 2006), it was focused on specific components in the models. Watson (1997) presented a three-tiered Statistical Literacy Hierarchy. These tiers are (a) an understanding of statistical terminology, (b) an understanding terminology in social contexts, and (c) the ability to question claims made without proper statistical justification (p. 2). Gal (2002) identified knowledge and dispositional elements that were essential for the development of statistical literacy. Knowledge elements (literacy, statistical knowledge, mathematical knowledge, context, critical questions) are the ability to use statistical and mathematical knowledge, critically evaluate and reason statistical information in a variety of contexts. Dispositional elements (beliefs, attitudes, and critical stance) consist of beliefs, concern, and willingness about the competence of applying current knowledge and skills (p. 4). In her statistical literacy model Watson (2006) presented context, task format, task motivation, data collection-representation-data analyses-inference, variation, literacy skills, and mathematical/statistical skills components. When we analyzed models, it was seen that Gal (2002) and Watson (2006) models show more resemblance. At the same time one component is more restricted in one of the models could be discussed in a wider extent in other models. Also components which are emphasized in all three models draw attention. However, they are called with different names; context and understanding the concepts and terminology components take place in all three models. It was realized that it could be very difficult to distinguish different components in models. Therefore it was planned to adopt a model which includes components in all these models in the literature and help us to distinguish differences between components. Although critical approach is taken part in Gal (2002) and Watson (1997) models separately, this component is not represented in Watson (2006) model. But statements related critical approach and questioning could be seen in the component of mathematical-statistical skills in this model. And also the importance to develop critical stance and critically evaluate skills is emphasized (Gal, 2002). So, it seems necessary to provide critical approach component in our statistical literacy model. As determining the components of statistical literacy model both literature and possible situations that could be observed at instruction are considered. However, dispositional factors such as motivation, concern are considered besides knowledge elements in the literature, it is thought that it would be difficult to observe this factor in the statistics classroom environment. Therefore dispositional factors are not addressed within the scope of this study. Since statistical process component, including sampling, data collection and representation, and interpreting and inference stages was presented only in Watson (2006) model separately, these stages were seen in the statistical knowledge component of Gal (2002) model. Also Newton, Dietiker, and Horvath (2011) highlighted statistical process stages as important for statistical knowledge. Weiland (2017) referred a statistical process to explain statistical literacy as underlining some competencies as formulating statistical questions, collecting data for these problems, analyzing data with proper methods and displaying data in graphs, interpreting the data as addressing the questions and discussing about the meaning of the statistical information. In this way it is important to address statistical process basing on the efforts of individuals on statistical phenomena in statistical literacy model. As synthesizing statistical literacy models given in the literature in her model Özmen (2015) addressed *Statistical process*, *Reasoning*, *Basic Concepts*, and *Context* components. Statistical literacy model and the relationship between models in literature are summarized with Figure 1 as below:

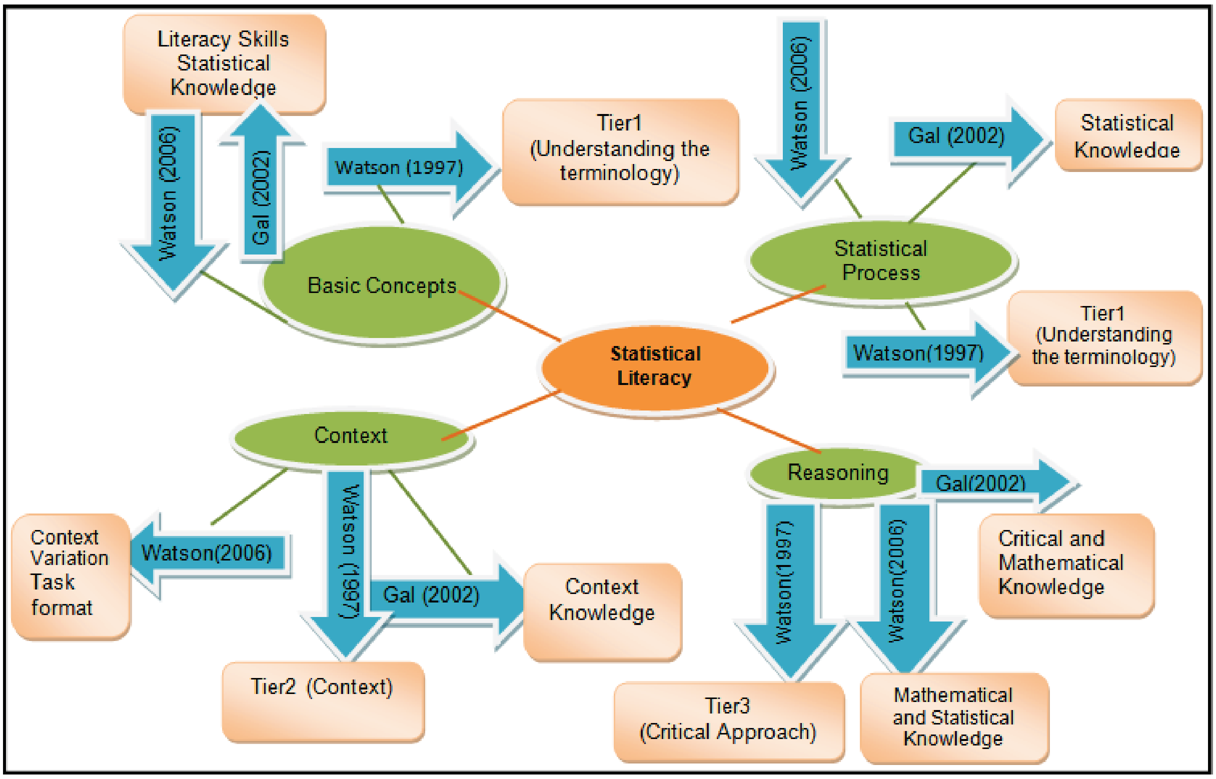

Figure 1. Özmen's (2015) Statistical Literacy Model and the Relationship between Other Models in Literature

This study based on statistical literacy model components and aspects related these components to evaluate the practices of instructors who teach statistics courses different undergraduate programs in terms of statistical literacy. The necessity of the reforms aimed to develop statistics courses and instructions is addressed clearly in the literature. Before the reform to be held in any field, determining the current situation is also important for being reform effective. At this point it is important to picture how the statistics course contents and practices in these courses contribute to statistical literacy.

Method

In this study, aimed to evaluate the practices of instructors who teach statistics a course in different undergraduate programs in terms of statistical literacy, a design which presents comparisons and associations by the help of quantitative and qualitative analysis is followed. The participants of the study consisted of nine instructors teaching statistics courses at nine different disciplines. In order to evaluate the practices of the instructors in terms of statistical literacy, observations were made. Data obtained by observations from statistics course instructions was analyzed through the rubric, developed by Özmen (2015) for statistical literacy practices. Firstly descriptive statistics as frequencies and percentages were calculated and graphs were drawn for statistical literacy aspects. Then, statistical analysis was performed to determine whether the distribution of frequencies for statistical literacy components is related with program.

Participants

The participants of the study consisted of nine instructors teaching statistics courses at nine different disciplines (labor economy and industrial relations (LEIR), geological engineering (GE), elementary school mathematics education (EME), consulting and psychological counseling (CP), secondary school mathematics education - department of mathematics (MEM), department of biology (BIO), urban and regional planning (URP), general medicine (GM), forest industry engineering (FIE)) in a state university. The purpose of selecting these instructors from different disciplines is to clarify how their perceptions of statistical literacy differ through their professions. Therefore selection of these disciplines would provide a diverse picture of the components of statistical literacy in statistics courses and have high level representativeness of population of the statistics courses. Demographic information the participants were given in table 1 below:

Table 1. Demographic Information for the Participants

Instructor	Doctoral/Expertise Field	Professional Experience
LEIR	Econometrics	28 years
GE	Geological Sciences	22 years
EME	Mathematics Education	7 years
CP	Consulting and Psychological Counseling	11 years
MEM	Applied Mathematics	28 years
BIO	Biology	23 years
URP	Urban and Regional Planning	8 years
GM	Public Health	17 years
FIE	Forest Engineering	21 years

Data Collection Tools

The qualitative data of this study which aimed to evaluate the practices of instructors who teach statistics courses in different undergraduate programs in terms of statistical literacy is consisted of classroom observations, field notes and interviews with instructors. In order to determine at which point statistical literacy is emphasized in statistics lessons, classrooms observations were made during a semester. Researcher recorded observation notes after lessons were followed. But it was thought that reflecting the points emphasized or avoided by instructors only from the researcher's eyes could cause some limitations. Therefore it was decided to interview with instructors after observations.

Observations were carried out in statistics courses at nine different programs in every week for a term. Course content, explanations, exemplary situations, the questions asked to students, answers from students, the questions asked to instructors and their answers were considered and observation notes were recorded. For the purpose of the study, observations in LEIR 48 hours, in GE 30 hours, in EME 40 hours, in CP 57 hours, in MEM 50 hours, in BIO 36 hours, in URP 42 hours, in GM 21 hours, in

FIE 33 hours were made. Also interviews were carried out with nine instructors. In these interviews it was talked about their reasons to remark some activities as recalling these activities. For example, it was asked to URP instructor that why she used the example called as "*the story of two data sets*" while she was teaching central dispersion measures as below:

> *While teaching central dispersion measures, you used an example called as "the story of two data sets". What do you aim at using this example?*

With this question it was aimed to determine the reason to rank this example as teaching central dispersion measures. Classroom observations and interviews were supported with field notes if it was necessary.

Data Analyses

Data of this study were analyzed both qualitative and quantitative approaches. Data obtained by observations from statistics course instructions was analyzed through the rubric, developed and determined validity by Özmen (2015) for statistical literacy practices. This rubric consisted of statistical literacy model components as *statistical process* (9 aspects), *reasoning* (11 aspects), *basic concepts* (5 aspects) and *context* (13 aspects) and totally 38 aspects (see appendix for rubric). Instructors' practices were evaluated under these aspects in terms of statistical literacy.

Data were analyzed through aspects in rubric after recording data. After first hand analyses were completed, researcher coded all observations again with a copy of data including any information about first analyses. Comparing both coding, using the formula of *common code/ total code* the reliability of researcher's coding was calculated 0.78. Also researcher organized the data as comparing two analyses. Then data was re-analyzed and data analyses were completed.

While observations were analyzed, code related aspect was written the end of the statement. Both a data could be related with one more than aspects and an aspect could be encountered one more than times in an observation data. For example, an exemplary coding for a part of lesson in EME program as below:

> *Well, would standard deviation be negative?*[R-6] *Look at. The procedure is followed as calculating the standard deviation. We subtract it from the arithmetic mean, and then we take the square of it and add all these values. Then we devise this total value to n-1. It cannot be negative.*[R-8] *But you calculate it negative in the exam, be careful about this.*[C-13]

Firstly instructor asked to students a critical question to provide students' thinking about whether standard deviation would be negative. Due to this kind of question is related with the aspect of using critical question, code of R-6 (using critical questions) was written at the end of the statement. While instructor explained why the standard deviation cannot be negative, he paid attention to mathematical foundations as taking the square of the differences between value and arithmetic mean. And so R-8 (mathematical foundations) aspect is emerged. Then the instructor warned students to be careful that standard deviation cannot be negative. This is coded as C-13 (refer possible mistakes, misconceptions, and bias) owing to instructor referred possible mistakes and misconceptions.

After the analyses of observations completed, frequencies of statistical literacy aspects for each program were determined. At the same time total frequencies for each component were obtained by the help of the frequencies of aspects. Comparisons were based on programs and average frequencies were calculated for each aspect related observations in a one hour lesson period by dividing total frequencies to the number of the observation hours. In order to compare the practices via statistical literacy components, total frequencies were divided to the number of the aspects involved in related component and average frequencies were calculated. By the help of these average frequencies graphs were drawn and comparisons were based on these graphs. And also these graphs provided an opportunity to determine which components are emphasized mostly or least at each program. Chi-Square Independent Test was performed to determine whether these differences and frequency distributions are statistically significant for each component. Data obtained by interviews was analyzed qualitatively and presented in findings section as supporting the observation notes.

Results

In this section findings related with the evaluation of the practices of instructors who teach statistics courses in different undergraduate programs in terms of statistical literacy were presented.

Evaluating the Practices in Terms of Statistical Process Component

Practices about statistical process component have generally low percentages at all programs. In this component, the aspects were taken place in the practices as independently from each other rather than an investigation process. It was seen that practices for this component in EME and URP lessons are differed from other programs in this way. EME and URP instructors practiced this component as an investigation process in their statistics lessons. For example, EME instructor generally follows a process as determining the problem with students, asked students to predict if the context is permitting, collecting data from the classroom, organizing the data and interpreting the results with the relevant context. We could summarize how this component takes place in EME lessons as below:

EME instructor wanted all students to bring match boxes and one student to bring a ruler for the next lesson. But he made any explanations about why he wanted these objects. When he taught the confidence interval for the difference between two population means, it was understood that why he wanted the ruler. After instructor took the ruler, he wanted students to predict the length of the line segment which he drew on the board and asked them for their predictions. He put an emphasis on students' own predictions as below:

-Think quietly. Make your own prediction. You are not influenced by someone else's thoughts.

Therefore he encouraged students to make their own prediction. Instructor writes their predictions on the board and gives opportunity to students to make different analysis by considering students' genders. After students made predictions, instructor posed problem suitable for the data as below:

-Students predictions about the length of the line segment drawn by an instructor as followed. Determine the confidence intervals with 90 % confidence level for this prediction results?

It is asked to students to tell about the mean and standard deviation value of the data. By the help of the students' answers, he noted the mean and standard deviation values on the board. Confidence interval is calculated as (82.9–91.71). After determining the confidence interval,

-When we measure, we can see whether you are good predictors

with this statement he drew attention to consider results within the context. Also students had an opportunity to evaluate their own predictions in terms of the real-like. Not only predictions emerged as numerical values but also these predictions are interpreted within the context. Moreover instructor has ruler gotten closer to the line and wanted students to consider their predictions and predict a new value as below:

-Wait, I zoom in the ruler. And I will give you a reference. Now look at this reference and tell your predictions again.

Instructor learned students' second predictions and wrote them on the board respectively their first predictions. After students' predictions were written after a reference point, by the help of a student instructor measured the length of the line as 94 cm. After measuring the length of the line segment,

-How is this prediction? It was measured as 94. What does it mean? It means that you make a false prediction in class. Therefore, the reference was very important at measurement.

comments on the truth of the predictions were talked as above. Thus, the result is considered with the context of the problem. Also, students get experienced a statistical process as determining the problem status, collecting data from the class, organizing and analyzing the data, interpreting the results with the relevant context of the problem. EME instructor explained his reason for determining a problem related with real-life situations and considering a process based on students' active participation for this problem's solution as below:

> *-Because related with the daily life and our topics such as are there any differences between pre and post predictions to perform dependent t test? Or are there any differences between the predictions of girls and boys to perform independent t test? They want to see the results of their own interest. In fact this is a metacognition. I try to direct them on their thinking.*

Instructor stressed that he aimed to provide students' participation more actively to the lesson as associating with the daily life. Also he summarized the process that he followed as:

> *-We try students to participate the process whether they wonder anything. First students make comments about their own. In fact this is the lowest level of the statistical literacy. They infer from a few examples that they encountered or build in their mind. Then they developed a prediction on their own. But this prediction has any mathematical foundation. They tell that I think students take weight in their university years. Such as the predict-observe-explain method in sciences. In other words, they make a prediction, data is their observations. After that they try to explain it. They experience a process about why the similar or different result with their prediction.*

Instructor associated this process with predict-observe-explain in science. In other programs, the aspects of statistical literacy components were taken place independently from each other. In these programs this component was not considered as an investigation process. Generally as using visual representations (SP-7), interpreting table and graphs (SP-8) and interpreting the results with the relevant context (SP-9) aspects were emphasized and the aspects of this component were taken place at courses independently. The average frequencies of the aspects of the statistical process component considering total lesson hours are given with the table 2 below.

Table 2. The Distribution of the Frequencies of the Statistical Process Component via Programs

Code*	LEIR	GE	EME	CP	MEM	BIO	URP	GM	FIE
SP-1	0,021	0	0,375	0	0	0,027	0,071	0	0
SP-2	0,021	0,066	0,325	0,105	0	0,111	0,071	0,142	0,272
SP-3	0,021	0	0,125	0,052	0	0,055	0,261	0	0,121
SP-4	0,062	0	0,45	0	0	0	0,023	0,047	0
SP-5	0,312	0,233	0,325	0,28	0,16	0,361	0,5	0	0,06
SP-6	0,042	0	0,1	0,333	0,02	0,083	0,214	0,238	0,242
SP-7	1,000	1	0,475	0,473	0,38	0,75	0,5	0,523	0,606
SP-8	0,833	0,933	0,325	0,298	0,14	0,222	0,547	0,809	0,303
SP-9	0,271	0,6	0,6	0,473	0,14	0,861	0,190	0,714	0,636

*Average frequencies were calculated by dividing total frequencies to the total lesson hours for each program.

When the table was analyzed, it was seen that SP-1 (determining the problem situation), SP-2 (making hypothesis or conjectures), SP-4 (collecting data from the classroom environment) aspects at EME, SP-3 (collecting data) and SP-5 (organizing data) aspects at URP, SP-6 (determining sample and referring the importance of sample) aspect at CP, SP-7 (using visual representations) aspect at LEIR, SP-8 (interpreting table and graphs) aspect at GE and SP-9 (interpreting the results with the relevant context) aspect was used at BIO program. While SP-1, SP-2, SP-3, SP-4 aspects are addressed at least, SP-7 aspect is addressed mostly in statistics lessons within the statistical process component.

It was seen that some aspects of the statistical process component were emphasized more comprehensively and at certain programs and came into prominence. As an example, although almost all instructors pointed out SP-6 (determining sample and referring the importance of sample) aspect in their lessons, this aspect had an important place at CP lessons. In CP lessons, the necessity of the representation of the population and the importance of the determining the sample were explained frequently based on different daily life examples. For example, CP instructor stressed at the importance of the determining sample as below:

> *-What do nut sellers as buying nuts? They look at the outputs. What is the goal? Output must be 50. How they look at? If they say that they will break all of them, this will take a lot of time. On the contrary, it they say that they will break only one nut, this would be risky too. We must determine the sample that will well represent.*

CP instructor explained the importance of the sample based on the nuts which is the mainstay of the region. He drew attention to determine sample properly to collect data compliant with the research problem as moving from the daily life examples. He addressed at explaining the importance of the sample based on outputs of the nuts as,

> *- Sometimes theoretic knowledge is not enough. Nuts and similar examples could create more high level awareness due to be life product directly. At the time I think they grasp the subject concretely. Ultimately, each nut does not represent the all nuts. Therefore your false choices could cause much loss or more gains. Due to reach all of the people are not possible in terms of the time and labor, I try to emphasize the ways which would be to represent.*

contributing students to embody concepts and associate these concepts with their daily lives. Similarly, SP-9 aspect were encountered at all programs, but this aspect had an important place at GM, BIO, FIE, EME, and GE lessons. For example, GE instructor certainly interpreted the results obtained from problems within the related context. After the hypothesis about whether a case granite is belongs to the Gümüşhane population was tested, GE instructor,

> *-Yes, is it ok? It stays in the accept area. What we will tell about? So students take the granite examples from the right place. Samples belong to the Gümüşhane granite population.*

interpreted the results within the related context as above and completed the solution of the problem. Thus students had an opportunity to see that what obtained results mean in terms of the context. And he stated that he paid attention to develop students' interpretation skills as below:

> *-If you don't write the results in this way in the exam, most of your point is taken off. And I pay attention to students' understandings.*

If students don't interpret the obtained results like practices in the lessons, he warns students about cutting their scores due to idea that students did not understand the problem. This showed that not only instructor considered the right results but also he cared about interpreting the results with the relevant context. While SP-1 and SP-4 aspects did not take place at other programs, EME instructor gave place to practices about collecting data from the class and determining the problem. Similarly SP-3 aspect did not take place in instructors' practices too. But URP instructor often emphasized the importance of the collecting the data properly. For example, in her lessons URP instructor stressed at collecting the data properly as below:

> *-For instance, if you ask about study related the nuclear energy in Trabzon, many people don't know and aren't interested in. if you ask this study in Sinop, I am sure that they will be interested in. Or, you want to investigate the effect of the stadium on the environment; do you determine your sample from the Boztepe? No, you must determine people as affecting from the stadium.*

URP instructor drew attention to the importance of collecting data properly in their research as giving daily life examples. It was seen that practices related statistical process component are differed among the programs. In order to determine whether the distribution of the practices among the programs is statistically significant, Chi-Square analysis was performed. As a result of Chi-Square analysis, it was seen that the distribution of the aspects of the statistical process component is related with the programs (χ^2=242.295, p=.000<.05). In other words, it was realized that the distribution of the frequencies of the aspects of statistical process component is related with the programs.

Evaluating the Practices in Terms of Reasoning Component

When the statistics courses were analyzed in terms of the reasoning component, it was seen that this component ant its' aspects had a wide coverage and high percentage in particular programs. Generally asking critical questions, make inferences and evaluations based on data aspects are discussed. Especially, this component appears at EME, LEIR, FIE, GE, and MEM programs. In these instructors' practices mathematical foundations are the weight and questions referred to students' thinking. For example, LEIR instructor emphasized as:

> *-I ask these questions because I want to students to develop critical viewpoints.*

He aimed to students' being developed an understanding. And LEIR instructor explained about giving the importance of the critical thinking in his lessons as below:

> *-My teaching method is to provide students transferring reasoning skills to professional lives during problem solving activities.*

Instructor stated that he gives importance and uses this kind of questions for students' transferring their reasoning skills to their professional lives. However, reasoning component has not central place at URP, CP, BIO, and GM programs. Especially in her practices GM instructor avoided to focus on calculation, procedures and formulas and did not preferred to organize their curse contents based on mathematical foundations. GM instructor explained her reason to avoid statistics course contents that based on calculation, procedure and formulas as below:

> *-We changed our course content compared the before. Before we used to show how these calculations were made one by one. Therefore, lesson hours were more than now. We could not calculate the formulas by hand activities. It requires so many time. Thus, we try to focus on how students interpret the results and transfer these results to clinical field and students to know what these results mean rather than calculating.*

Instructor stated that she organized course contents which based on a theoretical structure at the last and avoided to give place to calculating by hand activities. She explained about why she avoided calculation based lessons with the idea of the being time wasted. Also she stressed that she gave importance to students' transferring their knowledge on situations they encountered rather than calculations. The average frequencies of the aspects of the reasoning component considering total lesson hours are given with the table 3 below.

Table 3. The Distribution of the Frequencies of the Reasoning Component via Programs

Code	LEIR	GE	EME	CP	MEM	BIO	URP	GM	FIE
R-1	0,125	0,066	0,25	0,052	0,08	0,027	0,095	0,142	0,181
R-2	0,396	0,333	0,525	0,28	0,2	0,25	0,214	0,571	0,212
R-3	0	0,166	0,15	0,017	0	0	0,095	0,19	0
R-4	0	0,366	0,4	0,07	0,04	0,083	0,095	0	0
R-5	0	0,166	0,125	0,017	0	0	0,047	0	0,03
R-6	1,646	1,166	1,675	0,438	0,22	0,472	0,738	0,666	1,636
R-7	0,479	0,733	0,6	0,491	0,28	0,555	0,547	0,38	0,333
R-8	0,687	0,7	0,65	0,07	0,24	0,194	0,166	0,095	0,757
R-9	0,271	0,166	0,275	0,087	0,1	0,027	0,095	0	0
R-10	0,916	1,2	1,025	0,35	0,56	1,222	0,547	1,238	1,333
R-11	0,125	0,1	0,225	0,05	0,46	0,166	0,095	0,142	0,03

When the table was analyzed, it was seen that R-8 (mathematical foundations) and R-10 (making evaluation and inferences on data) aspects at FIE; R-1 (taking into consideration different sample sizes), R-4 (providing students' communications), R-6 (using critical question) and R-9 (providing students' thinking on the statistical formulas) aspects at EME; R-3 (providing students' discuss on the most appropriate data representation), R-5 (providing students' discuss on different opinions) and R-7 (explaining why the methods are used) at GE, R-2 (discussions about the effect of variables on the results) aspect was used at GM and R-11 (providing students' making generalizations from the obtained results) aspect was used at MEM program more frequently. R-6 and R-10 aspects are mostly addressed in statistics lessons within the reasoning component. Although, reasoning component did not remain at the front of the GM lessons, R-2 aspect mostly emphasized at this program. Instructor generally talks about the effect of the variables on the results. For example, instructor stated the effect of the p value as:

-As p value gets lower, the results of your research get high reliability.

It was emphasized that the result of the research would be more reliable depending on the low p value. In many programs R-3, R-4 and R-5 aspects were not considered. On the contrary these aspects were more common at EME and GE programs. LEIR, GE, EME and FIE instructors referred to R-8 aspect (draw attention to the mathematical foundations) more than other instructors. They generally make explanations as remarking the mathematical situations which underlie topics or concepts. For example, GE instructor stressed that they must consider the size of the circle and the center angle of the pies. For example, he underlined mathematical foundations that how they draw the distribution of the minerals at different cities

-Given that we draw graphs for the same minerals cities of Trabzon, Rize, and Samsun. When we compare different cities, we could not draw graphs with the same size. These radiuses should be proportional to the total frequencies. How would we compare the radius? Of course moving from the area of these cities. $r_T{:}r_R{:}r_S = \sqrt{F_T}{:}\sqrt{F_R}{:}\sqrt{F_S}$. *We did it to compare.*

Instructor compared the areas by the help of the surface of the cities. He except from students to realize the radius of the cities is proportional with the square of the surface. He underlined that like angles, the size of the circle would differ by depending on the surface of the regions. JEO instructor explained his reason for underlying the mathematical foundations and drawing the pie charts as considering the pies and angles as below:

-Without the help of the computers, they can easily draw own selves and know how it is prepared with this teaching method.

JEO instructor cared about that students could see how they calculate the angles while drawing these graphs without any help of the computers. It was seen that practices related reasoning component are differed among the programs. In order to determine whether the distribution of the practices among the programs is statistically significant, Chi-Square analysis was performed. As a result of Chi-Square analysis, it was seen that the distribution of the aspects of the reasoning component is related with the programs (χ^2=258.338, p=.000<.05). In other words, it was realized that the distribution of the frequencies of the aspects of reasoning component is related with the programs.

Evaluating the Practices in Terms of Basic Concepts Component

When the statistic courses were evaluated in terms of the basic concepts component, this component was encountered at all programs. This component appeared mostly at LEIR program and at least MEM programs. EME, GM and GE programs followed LEIR. The average frequencies of the aspects of this component considering total lesson hours are given with the table 4 below.

Table 4. The Distribution of the Frequencies of the Basic Concepts Component via Programs

Code	LEIR	GE	EME	CP	MEM	BIO	URP	GM	FIE
BC-1	0,437	0,333	0,547	0,14	0,08	0,333	0,547	0,38	0,303
BC-2	0	0,066	0,047	0,087	0	0	0,047	0,095	0
BC-3	1,458	0,833	0,761	0,912	0,26	0,666	0,547	1,142	0,575
BC-4	0,375	0,666	0,357	0,298	0,18	0,472	0,285	0,523	0,272
BC-5	0,583	0,333	0,595	0,122	0,2	0,277	0,190	0,095	0,121

When the table 4 was analyzed, BC-1 (asking students to express their understandings) aspects at EME and URP, BC-2 (providing that students write their opinions) aspect at CP, BC-3 (talking about the meanings of the concepts) aspect at LEIR, BC-4 (draw attention to the relationship between concepts) aspect at GE and BC-5 (adopting the terminology of the statistics) aspect was seen mostly at EME program. Although practices for basic concepts component are favor at statistics courses, these practices were centered on BC-3 aspect. While this aspect takes place at all program, BC-1 and BC-2 aspects are encountered at least. In other words, as instructors stressed to talk about the meaning of the topics or concepts, practices were not enough to want students to express or write their ideas. Instructors generally refer BC-3 aspect in entry section of the lesson or teaching a concept or subject firstly. This component and especially BC-3 aspect has am important place at LEIR lessons. The instructor talked about in detail while teaching a concept or subject or the entry section of the lesson. He associated the concepts with professional or daily lives while he talked about the meanings of the concepts. For example, he explained that what H_0 and H_1 hypothesizes mean as:

-Hypothesis testing resembles to judgment process of a court. Claimants and defendants come to the court with several claims. The case files are examined through the evidence. The prosecutor presents his/her claim about case file and tries to support the claim as showing that this person committed an offense with these evidences. The personal claim of the prosecutor is H_1. These claims and files are sent to the judge. And judge seeks the evidences like H_0 as thinking that defendant is not guilty. If judge did not find any evidence which supports the claims of the prosecutor, defendant is not guilty. In other words, H_0 is valid. There is not enough evidence to accept the claims of the prosecutor. Therefore defendant is not guilty. If H_0 is not defended, it is rejected and H_1 is accepted.

The instructor talked about hypothesis testing process, what H_0 and H_1 hypothesizes mean as associating them with daily life situations. LEIR instructor explained that why he lead in this form and talked about what these concepts mean as referring the example of judgment process as below:

> *-Students like these examples. When you look at the eyes of the students, I realize that they say that ok we understand in their mind. These kinds of examples are directly related with the daily life. I try to provide student's understandings unknowns moving from the known. People are interested in judgment process. Also they are informed about the judgment process. What does defendant mean? Why it is called as defendant? What is the role of the prosecutor? I think this example is very interesting for understanding the subject.*

He stressed that these kinds of exemplifications help students to develop an embodied understanding for concepts. Also he stated that he preferred to associate hypothesis testing with judgment process in their daily lives due to people are interested in this kind of example. BC-4 aspect is referred to support the similarities or differences between different concepts. For example, GE instructor drew attention to the relationship between the concepts after he talked about the meaning of the subject or concept. After the instructor taught probability distributions, he talked about the relationship between Bernoulli and Binomial distributions as:

> *-"r", the number of the successful cases is the wanted. Bernoulli distribution is a special form of the Binomial distribution. If the number of the trials is 1, this is Bernoulli. If the number of the trials is more than 1, this is Binomial distribution.*

So instructor tries students to notice the relationship between Binomial and Bernoulli distributions. BC-5 aspect is mostly referred by EME instructor. He certainly refers the symbol or notation of the terms or concepts, and so he tries to make students adopting the terminology. The statements about using the proper notation are often encountered. Terminology is generally emphasized not to confuse parameters and statistics. For example the instructor,

> *-Because of this is a sample and dividing to n-1, I wrote $\bar{X}$ above in the formula. If we calculate based on the population, I would write μ in the formula… As a result, if the population mean isμ, the mean of sample means distributions is μ too.*

emphasized that which notation must be used when they consider arithmetic mean of the population and sample in statistics lessons. It was seen that practices related basic concepts component are differed among the programs. In order to determine whether the distribution of the practices among the programs is statistically significant, Chi-Square analysis was performed. As a result of Chi-Square analysis, it was seen that the distribution of the aspects of the basic concepts component is related with the programs (χ^2=73.145, p=.000<.05). In other words, it was realized that the distribution of the frequencies of the aspects of basic concepts component is related with the programs.

Evaluating the Practices in Terms of Context Component

It was seen that context component is mostly referred in some programs, on the contrary this component is least referred in other programs. Context component appeared mostly at GM program. BIO and EME programs followed GM. Context component appeared at least MEM program. The average frequencies of the aspects of context component considering total lesson hours are given with the table 5 below.

Table 5. The Distribution of the Frequencies of the Context Component via Programs

Code	LEIR	GE	EME	CP	MEM	BIO	URP	GM	FIE
C-1	0,25	0,433	0,976	0,433	0,2	1,25	0,095	0,523	0,545
C-2	0,729	0,933	0,761	0,966	0,2	0,777	1	1,333	0,484
C-3	0	0,066	0,095	0,083	0	0	0,19	0,095	0
C-4	0	0	0	0	0	0	0	0,380	0
C-5	0,104	0,166	0,285	0,3	0,08	0,472	0,452	0,809	0,393
C-6	0	0	0	0,083	0	0	0,285	0,523	0
C-7	0,021	0	0,166	0	0,26	0,138	0,095	0	0,121
C-8	0,292	0,266	0,142	0	0,32	0,027	0,119	0	0,212
C-9	0,25	0,333	0,452	0,283	0,06	0,583	0,166	0,523	0,272
C-10	0,708	0,733	0,380	0,133	0,12	0,472	0,285	0,238	0,757
C-11	0,25	0,133	0,142	0,066	0	0,083	0,047	0,142	0,121
C-12	0,042	0,133	0,142	0,016	0,08	0,138	0,071	0,047	0,242
C-13	1,125	0,866	0,833	0,65	0,24	0,833	0,761	0,428	1,181

When the table 5 was analyzed C-1 (presenting problem situations within the context) EME; C-2 (using examples and statements related with daily lives), C-4 (interpreting the data in a wider context news or articles), C-5 (informing students about the importance on their professional lives) and C-6 (benefit from the technology) GM; C-3 (asking students to give examples) URP; C-7 (give students homework, project etc.), C-8 (making connections between different subjects) MEM, C-9 (informing students about how they apply statistical terminology on encountered context) BIO; C-11 (draw attention to the variation concept) LEIR, C-10 (emphasize the changes on data), C-12 (referring context based on reasoning) and C-13 (refer possible mistakes, misconceptions, and bias) were mostly seen at FIE program. While C-2 and C-13 aspects were referred mostly, C-3, C-4 and C-6 aspects were seen at least within context component. Instructors generally refer to daily or professional life examples in their practice while they explain subject or concepts. For example, examples referred in CP lessons are generally related with students' daily or professional lives. As an example, the instructor exemplified the interval corresponding $\mp$ 2 standard deviation as,

> *-Women whose shoe sizes betweenc37-40 correspond to this interval. Why? Because factories produce shoes considering this interval. For example, 41, 42, 43 are favor shoe sizes for men. Lessons are compliant with this distribution too. For example, if the success average of a class is 20%, this doesn't behave like normal distribution. Or everybody could not take 95.this does not behave like normal distribution too.*

associating with the shoe sizes which are common among the women and men for the subject of normal distribution. By the help of this kind of examples he tries to stress that many cases surround us compliant with the normal distribution. He justified the reason to use this kind of examples in their lessons as,

> *-For example, you will interfere in depressive case or tendencies in your school. You must reach a result. Or you want to develop a social skill, as a specific problem you will study on intelligence. Consequently, I try to prefer crucial examples as possible. I use these examples due to they are encountered frequently.*

students being often encountered in their professional lives.

Not only examples but also problems which take place into course content are presented within a context. Especially instructors determine context of these problems as considering their professional lives. For example, BIO instructor absolutely presented problems within the context and these problems are generally related with the biology field such as barley breeding, wheat breading, insecticide, teaberry, calf feeding. For example,

> *-An experiment of the yield of fertilizer was performed to determine the effect of the nitrogen fertilizer on yield for wheat. Nitrogen fertilizer was applied with the proportion of 0%, 1%, 2.5%, 5%, 10%, and 15%. Determine whether are there any significant difference between these proportions in terms of the effects on yield?*

he referred to problem situations which includes professional terms such as the fertilizer of the nitrogen for wheat. BIO instructor explained his reason to refer the terms related with biology field in problem situations as below:

> *-Tomorrow, when they research. Where I can apply? We used to solve this kind of example. It was used in these areas. I try to evoke for them.*

Instructor stressed that he referred professional live contexts to be evoked by students when students encounter similar problem situations in the future. Associating with professional and daily lives is not only during the presentation of problem situations or examples but also during how a subject or concept utilizes their lives (C-5). But this aspect is more limited in practices. This aspect is referred mostly at GM program. Especially she ranks the subjects related with medical sciences. GM instructor exemplified that how students could transfer the subject of regression to their professional lives as:

> *-We want to see that how these factors affect hemoglobin. Look at! $R=0.92$ $R^2=0.84$ $p=0.000$. The relationship between hemoglobin and iron is significant. What does it mean? If you know the daily amount of the iron for your patient, you can determine the hemoglobin value without measuring blood pressure using the $Y(Hb)=7.572+0.462X(Fe)$ regression equation with probability of 84%.*

Instructor stressed that they can determine the blood value thanks to regression analysis if they know the amount of iron. Also students have opportunity to transfer their probability knowledge to their professional lives too. However, C-4 and C-6 aspects are not emphasized commonly in terms of statistical literacy, these aspects are referred mostly at GM practices. The instructor reinforced the subject of parametric and non-parametric tests with a sample article in which related test was performed and obtained results in this article are interpreted. So, as bringing articles related medical sciences written in Turkish or English form, instructor contributes students to interpret the results obtained from these studies. For example, firstly they analyze an article about A-DES in physiological field and then they talked about the analysis methods and results of this study.

> *-There is a concept in psychology called as A-DES. In this study other variables which affect the A-DES would be explained. If you explain A-DES in terms of these variables, you can calculate the A-DES value by the help of these variables. I could inter two things. First I can determine the factors that affect it. And secondly I could see that how these factors affect it. Therefore regression analysis was performed.*

Instructor explained that the regression analysis was performed in this article due to researcher tries to explain A-DES based on variables. She drew attention to be determining the A-DES by the help of an equation consisted of this variables. The instructor gave explanations about referring the articles related medical sciences as:

> *-Because, you mention about literacy. I want them to infer about situations that lead to statistics between given. Why this kind of analysis was performed? How they reach this result? If they revive these stages, data is collected with this survey. I don't teach as biostatistics completely, I try to teach as a research. I think they will use this knowledge in this way.*

The instructor aimed to give place this kind of practices to provide that students would be able to informed about research process and see that how this research are carried out as analyzing the statistical results.

Practices in statistics lessons focused on referring possible mistakes, misconceptions and bias. These possible mistakes, misconceptions and bias are generally around the mathematical basis. Students are warned not to make mistakes based on mathematical basis. For example FIE instructor stated that comparisons only based on numerical values could cause mistakes as below:

> *-Last year, 5 students passed the paper course and 7 students passed the statistics course. Does that mean out here? Students whom take statistics course are more successful than. Where do we know? Maybe 100 students took paper course. And 200 students took the statistics courses. What does it mean? While paper course has a success level with 5%, statistics course has success level with 7%. So, sometimes percentage could present more certain information rather than numbers.*

The instructor stressed that students could make mistakes if they evaluate the result only based on numerical values and they could determine as considering percentages and rates. He warned students not to make mistakes for this kind of situations. Make a change on data (C-10) aspect is generally used to draw attention to differences between the results after the data were changed. Especially after the solution of the problem is completed, FIE instructor makes changes on data in the problem and asks students to solve this new problem. For example,

> *-The standard deviation of the distribution of the length in a forest with 17800 trees is 4.3 m. If the average length of the tree is estimated, how many sample tress must be chosen and their length will be measured with the 95% confidence interval and most ∓1.5 m error?*

Number of the trees to be measured this problem is calculated as 32. The instructor makes changes on error level and wants students to resolve the problem.

> *-Ok, for the same question what will happen if the confidence is constant and the error is reduced by half? If confidence is constant and errors are reduced by half, what sample size would be? (Increase). Yes, even I ensure that it quadruples. 125 copies now and we will spend 125 lira. If the cost for the first measurement is 32000, this will be 125000.*

He drew attention to how the results would change and affect cost as changing the error level. He explained his reason to make changes on the data of the problem as:

> *-I show this due to realize the changeable situations. And they affect. We often play with the numbers to juggle and adjust the budget. Sometimes it was asked that why you select many samples. There is a budget so we play with the level of confidence and error to use it.*

It is aimed to see that how they make changes on data to juggle and adjust the budget for their professional lives. And they have an opportunity to realize that how these changes affect the results.

Although practices about the context component of the statistical literacy are limited in MEM program, the aspect of associating with different subjects (C-8) is more common at MEM lessons. This aspect is generally referred to use the knowledge related last lessons or subjects in any stage of proof. For example, while the instructor proves the formula of the b_0 and b_1 coefficients in regression equations with The Least Squares Method as connecting with the maximal and minimal problems in derivative subject.

> *-You learned in calculus. You can calculate the maximal and minimal. You discussed in calculus. When you square the distance and take the derivative of this, you calculate the maximum and minimum values for the distance between two lines.*

So the instructor associated the being minimal of the squares of the difference between observed and real values with maximal-minimal problems.

It was seen that practices related context component are differed among the programs. In order to determine whether the distribution of the practices among the programs is statistically significant, Chi-Square analysis was performed. As a result of Chi-Square analysis, it was seen that the distribution of the aspects of the context component is related with the programs (χ^2=387.942, p=.00<.05). In other words, it was realized that the distribution of the frequencies of the aspects of context component is related with the programs. The comparison of the practices of statistical literacy in different programs is given with the graph below.

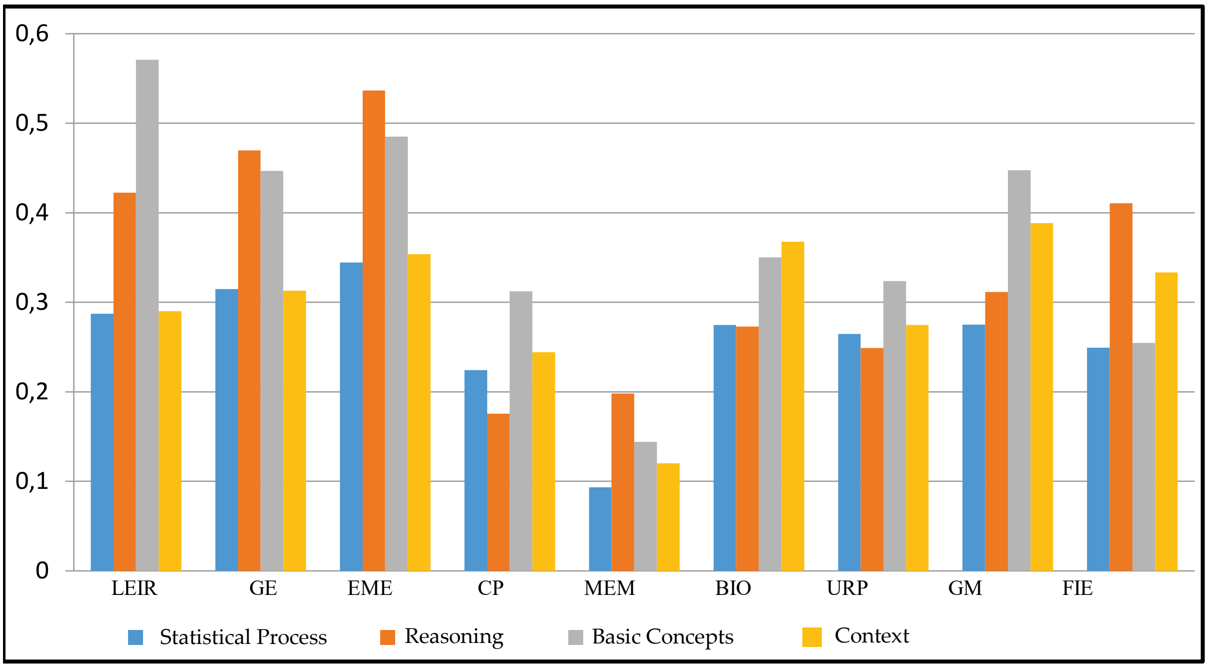

Figure 2. The Distribution of the Practices about Statistical Literacy Components via Programs

* For all programs total frequencies were obtained for each component and the average of these frequencies was calculated based on the lesson hours. As dividing these averages to the number of the aspects the average value of the aspect for each program were determined.

When the graph was analyzed it was seen that statistics courses practices referred at least statistical process and at most basic concepts component. Besides, the practices about reasoning and statistical process components were emphasized in EME, basic concepts component in LEIR and context component in GM program. Also, the practices about statistical literacy were encountered at least in MEM programs. On the contrary, reasoning component was referred at least in CP program.

Discussion and Conclusion

Different components were referred at different professional groups as evaluating the practices of statistics courses in terms of statistical literacy. In EME statistical process and reasoning, in LEIR basic concepts and reasoning, in BIO and GM context, in URP statistical process and context, in FIE context and reasoning, in GE and MEM reasoning, in CP context and basic concepts components are in the forefront of the practices. The approaches adopted by instructors, specialties of the instructors, goals of the courses and the extent of the professions could be effective on these differences.

It was seen that the practices about statistical process component were referred at least in statistics courses. Although statistical process aspects are referred at lessons, they revealed independently from each other. This shows that statistical process component is not take place as a process which starts with determining problem status and ends with interpreting the obtained results within the context in the practices of statistics courses. Therefore it was seen that statistics courses generally did not contribute to overarching goal stated by Rumsey (2002) as raising the investigation skills of students. But statistical process has a series of stages as determining the problem, collecting the data, determining the sample, analyzing and representing the data, interpreting obtained data within the context (Tukey, 1977). In this sense overtaking teacher centered approaches in statistics courses could be effective on the emergence of the practices related with research process. In EME and URP programs the aspects of statistical process component are not referred as independently from each other, these aspects take part in these programs as stages of the research process. At this point these two programs are differed from others in terms of practices about statistical process component and the aim of these practices. Students must be active in the practices to carry out this component as a process. It is thought that adopting the students centered approaches in their lessons is effective on taking account of this component as a research process in EME and URP programs. Besides, Bargagliotti (2012) stressed to make discussions on students' understanding how to collect information in order to answer a specific posed question instead of providing direct instruction of data collection tools. Therefore, it is understood that practices about statistical process component is not enough in terms of statistical literacy. And this result emerges an obstacle for students to gain experience a research process. Also being students getting experienced this kind of practices could be quite helpful for students who research or continue post-graduate education. Newton et al. (2011) also stressed that handling the stages of the statistical process with a holistic approach was significant in students' experiencing such stages as determining the problem, data collection etc. In this regard, it is thought that handling the stages of statistical process with a holistic approach will contribute to the improvement of competencies regarding the statistical process component.

When practices of statistics courses were evaluated in terms of the statistical process component, practices centered upon using visual representations (SP-7), interpreting the table and graphs (SP-8) and interpreting the obtained results with the relevant context (SP-9) aspects. On the contrary determining the problem (SP-1), making hypothesis or conjectures (SP-2), collecting data (SP-3) and collecting data from the classroom environment (SP-4) aspects are emphasized at least. Not being carried out statistics courses as a research process is effective on this result. The distributions of the statistical process aspect are differed in terms of the programs. And these differences were statistically significant. In other words, the distributions of the statistical process aspects did not behave randomly. Also this result supports the idea that statistical process component takes in account in EME and URP lessons differently. Besides, there is not a difference in terms of the practices about SP-7 and SP-9 aspects and these aspects are considered in all programs. The idea that being statistics involved with specific concepts and this raises the difficulties on understanding could be effective on referring to the visual representations by instructors. Reasons such as being theoretical knowledge is common in statistics lessons, presenting the concepts or the relationship between concepts in a concrete way, and summarizing the complicated situations to provide better understanding explain the importance of this aspect. Also, the obtained results are certainly interpreted with the relevant context. Such emphasis by instructors as if they interpret the obtained results with the relevant context, this result will be functional could be effective on referring to this aspect in classroom practices. Similarly in their study Gal and Garfield (1997) stressed that the solution of a statistical problem could be completed if only obtained results were interpreted with the relevant context. In this sense, it was understood that both aspects have a key role in statistical literacy.

Aspects of reasoning component are referred in all programs in the context of contributing the statistical literacy. Practices about this component are in the forefront for many programs except for CP and MEM programs. It is generally referred to reasoning component during the higher cognitive learning. Practices about reasoning component centered upon using critical questions (R-6), explaining why the methods are used (R-7), making evaluation and inferences on data (R-10) aspects. Practices about reasoning component are generally limited with these aspects. Critical approach has an important place at all of the statistics courses. Questions aiming to emerge reasons, why and how of the aspects for the followed steps are used during the lecturing. It was known that critical approach is important for statistical literacy (Gal, 2002; Watson, 1997). Thus, it was thought that adopting a critical approach provides the contribution to the statistical literacy of students. Although providing students' thinking on the formulas (R-9) and students' making generalizations from the obtained results (R-11) aspects were not referred during the statistics courses, these aspects were mostly referred at EME and LEIR programs. Also, the contribution of the MEM lessons to statistical literacy was centered upon these aspects. It was thought that such reasons as being these instructors graduated from the department related mathematics and adopted a critical approach to emphasize the reasons for their lecturing could be effective on referring these aspects in these programs. As considering the idea that statistics lessons involves many rule and formulas, it is thought that students' making sense of the foundations of the formulas and noticing the generalization of the obtained results could contribute to more permanent learning. However, referring at these aspects is limited with an abstract structure due to presenting the context theoretical and advanced knowledge. So, this result referred that practices in MEM lessons is not enough for contributing to statistical literacy. Besides, being underlined the theoretical context is directly related with their professional areas for MEM lessons. At this point, it is more likely to focusing on theoretical context comparing the other programs. Although subjects are taught in a theoretical structure, it is thought that adopting approaches, methods or techniques would contribute to the statistical literacy. Therefore, it is thought that adopting teacher centered approach effects the contribution of the practices on statistical literacy. Developing a critical stance and displaying a questioning attitude of students require having communication skills. Sharma, Doyle, Shandil, and Talakia'atu (2012) noted that students could be able to convey and discuss with their friends on their thoughts. However, providing that students to communicate with each other (R-4) and discuss on different opinions (R-5) aspects were not much referred at statistics courses. It was thought that adopting teacher centered approaches posed a challenge on occurring of these aspects. And referring both aspects in EME and GE programs, adopting student centered approach, supports this idea.

Basic concept is one of most referred component among the practices at statistics courses. The idea that being students have not any prior knowledge about statistics and take any preliminary phase of this course could be effective on the instructors' emphasis for the basic concepts component. Also the facts that statistics have a specific language and terminology, and involves many concepts are effective on referring to this component during the statistics lessons. The basic understanding of statistical language and terminology, and making sense of statistical concepts are seen important for statistical literacy (Gal, 2002; Watson, 1997). This component generally emerges as entering a new subject, explaining the meanings of the concepts and providing to realize the relationship between concepts. In this sense, talking about the meanings of the concepts (BC-3) and drawing attention to the relationship between concepts (BC-4) aspects are mostly referred at statistics courses. It was seen that LEIR lessons are differed from other programs in terms of the emphasis for BC-3 aspect. The instructor sometimes only talks about the meaning of the related subjects or concepts during the lesson according to the importance and extent of the subject. The aspect of writing the opinions about statistical situations (BC-2) is not referred at statistics lessons. Using the verbal language to explain the subjects or concepts or express the thoughts can be effective on referring this aspect at least. Also BC-1 aspect did not referred at statistics courses. In fact both aspects require to students' expressing the opinions orally or in writing and the presence of the communication as using the statistical language. In this way both aspects base on the same idea. It would be valuable for students to communicate with statistical language and instructors to provide the communication between students with the purposes of explaining and justifying their thinking (Sharma et al., 2012). However, practices aimed to raise or develop the communication skills of the students are not considered in statistics lessons. The aspect of adopting the specific language and terminology of the statistics (BC-5) was referred at least GM lessons and at most LEIR and EME lessons. Being the GM lessons away from the math-based content and theoretical knowledge and focus on practices about their professional lives can be showed as a reason not to refer this aspect. On the contrary referring the specific language and terminology of the statistics concepts remained at the forefront at LEIR and EME programs. Due to the math-based practices in these programs, it is thought that these two programs differ in this aspect.

When the practices were analyzed in terms of the context component, it was seen that all of the programs focused on practices about context component. Also, the practices about this component differed in terms of programs. Although basic concepts component has higher percent, practices about context component were at the forefront. Being the instructor's paid attention to explain the importance of concepts in their professional lives rather than theoretical knowledge, could be effective on being the context component in the forefront of the GM lessons. Also being referred to the aspects of informing students about the importance of their professional lives (C-5), data analyzing by the help of the technology (C-6) and interpreting the data in a wider context news or articles (C-4) by instructor, showed the importance of the context in terms of statistical literacy for GM program. And ranking to the examples or explanations based on daily life context (C-2) supported the importance of this component too. Practices about the role of the subjects or concepts in daily life context are referred at CP, URP and GM lessons more than others. Being the instructors' a member of the related program at the same time, in other words none instructor from the outside of the department carries out the statistics courses could be effective on this result. And it is thought that as gaining experience about the knowledge which they would use in their professional lives has an important place. When it was considered that all of the instructors participating of this study are members of the related programs, similar results are not met in other programs. And this shows that the instructors of CP, URP and GM programs associated statistics with their professional lives more detailed. However, the impact of the having these programs' wider practical fields in their professional lives is quite large. In order to explain variables and the relationships between variables in behavioral studies, statistics has been extensively used in CP program. Similarly, a doctor must update the fund of knowledge related professional field as following the current developments of the medical sciences. An urban and regional planner must make a research related with the city firstly and interpret the obtained results correctly. In other words they must refer to statistics during their professional lives. On the contrary students graduating from EME and MEM programs will be teachers. Examples directly related their professional lives were not much due to only referring to statistics for the situations related their personal developments. It was seen that the aspect of possible mistakes, misconceptions, and bias (C-13) was referred at most in context component at statistics courses. The idea that statistical concepts are convenient for confusing and statistics involves a wide range of concepts could be effective on this result. As a reason, instructors' statements that students could confuse concepts reinforce this assumption. It was seen that this aspect was referred at most FIE and LEIR lessons. Being the mathematical background of students in both programs is lower, paved the way for this result. Because this aspect is generally used by the time referring math based mistakes or misconceptions. By the time subjects or concepts are taught warnings were made related with the points which students may confuse. Instructors explain their reasons for referring possible mistakes, misconceptions or bias to prevent the misunderstandings of the students. And it is important for students to know and realize possible mistakes and misconceptions (Carmichael, Callingham, Watson, & Hay, 2009; Gal, 2002). However, referring this aspect around the math based explanations interfered with stressing on misconceptions. And it is thought that conceptual understandings of students would enrich as emphasizing possible mistakes and misconceptions in statistics lessons. Therefore, it is understood that this aspect has a key role in statistics lessons. And C-3, C-4 and C-6 aspects are not referred at statistics courses. However, interpreting the results within the wider context such as news, articles or different sources is seen as a key qualification for the statistical literacy (Gal, 2002; Watson, 2006). So it is understood that statistics courses did not contribute to statistical literacy in this way. Although C-2 aspect is referred mostly at statistics courses, asking students to give an example about the subjects or concepts (C-3) is not common between the courses. Due to this aspect is not often referred in lessons and could be included in C-2 aspect; it is thought that this aspect has not a key role. It was noted that transferring individuals' their knowledge on encountered contexts for the statistical literacy (Carmichael et al., 2009; Watson, 1997). However, the aspect of informing students about how they apply statistical terminology on encountered context (C-9) is not referred. In fact students familiar with the meaning of the statistical concepts or methods mean. But they have difficulties in determining methods which they will use in their solutions moving from the context, when students face a problem situation. On the contrary the aspect of explaining the reasons for the current methods is referred at most in statistics courses. Although instructors explain that which methods should be used in different situations, students are unsuccessful due not to have any experience about determining the suitable methods moving from the context. It was stated that statistics directly related with context and statistics must not have been thought as separate from the context (Gal, 2002; Watson, 2006). And being informed about statistical terminology is seen important (Gal, 2002; Watson, 1997, 2006). It was thought that students' challenges would be overcome by taking into account of practices associated with statistics terminology and context properly and students would be able to better understand some of process steps.

In this study we determined that some aspects having the key qualifications for the statistical literacy. It was seen that taking into account of SP-7, SP-8, SP-9, R-6, R-10, BC-3, C-1, C-2, C-5, and C-13 aspects in practices of statistics courses is seen important for contributing to statistical literacy. However, it was understood that C-3, C-8, SP-5, R-1, and C-11 aspects do not take a center place for statistical literacy, and these aspects can be included in other aspects. Although BC-1 and BC-2 aspects were not at the forefront of the practices of the statistics courses, it was seen that these aspects have a key role on contributing to statistical literacy. Therefore, it was understood that the functionality of an aspect not only depends on classroom practices. And key aspects were identified for statistical literacy based on the practices of statistics courses. Important steps would be taken to raise undergraduate students' statistical literacy levels if these aspects are taken into consideration at determining the course context and designing the practices. So, it is suggested that referring these aspect in statistical practices as stressing functional aspects. We can picture the practices of statistical literacy in statistics courses as below at figure 3:

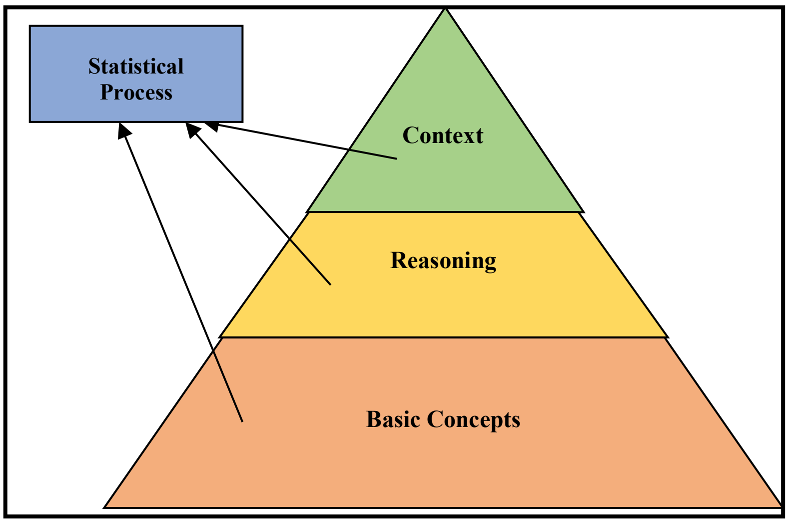

Figure 3. The Distribution of the Practices of Statistical Literacy Components at Statistics Lessons

As we can see, basic concepts component is referred at statistics courses more than. And practices about reasoning component follow this component. Practices about statistical process component are referred at least. Basic concepts component is often referred to in the entry of the subject or explaining the concept. Also, it was seen that context could appear in the every stages of the lesson and support to other components. And reasoning component generally appears during the higher level cognitive learning. And instructors refer this component after basic information about subjects or concepts are given. The component of the statistical process took place independently from the other components. And aspects of other components were referred in the practices related this component. In this way, it is thought that being practices related context component is spread to whole course, referring basic concepts component to enter the subjects or support to understanding, designing the reasoning component to transfer knowledge to high level thinking, and disseminating the statistical process component like a research process would contribute to statistical literacy. Thanks to this kind of practices, important developments would be gained through the aim of the raising individuals as statistically literate (GAISE, 2005, 2006; Gal, 2002; Mittag, 2010; Wallman, 1993). Also considering such aim as *"raising individuals as statistically literate"* will be an important step for statistics courses. Leppink, Broers, Imbos, Van der Vleuten, and Berger (2012) referred that for teachers to provide a sufficient instructional design is important to support a conceptual understanding of the statistical concepts. Furthermore, Whetstone (2014) stressed that not only statistics instructors make changes on their course contents but also they should use teaching methods that are aimed to develop conceptual understating of statistical concepts. Hybsova and Leppink (2015) stressed that if statistics educators aim at developing statistical literacy, they should make some changes on their instruction. Similarly, in this study it was revealed that instructors should make an attempt through statistical literacy in order to reflect statistical literacy in their instruction and to see the effect of this reflection better. Therefore it is suggested that revisions should be made based on statistical literacy as preparing the curriculum or textbooks and conceptual understanding should be considered in statistics instructions.

As a result of this study it was seen that the extent of the working area of the jobs shape the classroom practices. And this result provides that different aspects of statistical literacy could be important for different job groups. Also examples for classroom practices of instructors from different professional groups are presented in this study. In this way, instructors should incorporate their course contents with this kind of different practices and increase the contribution of their course contents to the statistical literacy.

In this study the contribution of the statistics courses to statistical literacy was evaluated by the help of practices which instructors used in their lessons and aspects having key qualifications were determined for the statistical literacy. By the help of a learning environment based on key aspects revealing in this study, further studies aimed to investigate the effect of the courses on the development of statistical literacy level of students should be carried out. Thus, the functionality of the aspects which are determined as having key qualifications for statistical literacy should be tested. Besides, the improvement of statistical literacy for students from pre-kindergarten to high school in all stages and individuals is pointed out (GAISE, 2005; Wallman, 1993). Statistical literacy aspects should be reviewed through lower class levels. And classroom practices related "data processing" learning domain should be evaluated in terms of statistical literacy for middle and high school. By the help of the results determined by this study, mathematics curriculum and textbooks should be reorganized including practices and activities which improve statistical literacy of students.

We focused on analyzing of the practices from different undergraduate programs in terms of the statistical literacy and making comparisons among the programs depending on these analyses. Undergraduate programs are related different professional groups and considering the nature of these professions, at most or at least referred statistical literacy components or aspects could be differed. This may be seen as a limitation in this study to make comparisons between programs. It was thought that if the course contents are supported with the appropriate instructional content, practices should be designed through all components and aspects of the statistical literacy in all professional groups. This idea supports the presented comparisons within the scope of this study.

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Appendix 1. Rubric for Statistical Literacy Practices (Özmen, 2015)

Component	Aspects	Code
Statistical Process	Determining the problem situation	SP-1
	Making hypothesis or conjectures	SP-2
	Collecting data to solve problem and providing students' talking about how the data would be collected	SP-3
	Collecting data from the classroom environment	SP-4
	Organizing data through	SP-5
	Determining sample and referring the importance of sample	SP-6
	Using visual representations	SP-7
	Interpreting table and graphs	SP-8
	Interpreting the results with the relevant context	SP-9
Reasoning	Taking into consideration of the problem statement for different sample sizes and providing students' discussions on different sample sizes	R-1
	Discussing about the effect of variables on the results	R-2
	Providing students' discuss on the most appropriate data representation	R-3
	Providing students' communications related statistical knowledge and understanding	R-4
	Providing students' discuss on different opinions	R-5
	Using critical question in classroom environment	R-6
	Explaining why the methods are used	R-7
	Draw attention to the mathematical foundations	R-8
	Providing students' thinking on the statistical formulas	R-9
	Making critical evaluation and inferences on data	R-10
	Providing students' making generalizations from the obtained results and making generalizations (based on statistically significance)	R-11
Basic Concepts	Asking students to express what they understand from statistical statements	BC-1
	Providing that students write their opinions related statistical situations	BC-2
	Talking about the meanings of the concepts	BC-3
	Draw attention to the relationship between concepts	BC-4
	Adopting the specific language and terminology of the statistics	BC-5
Context	Presenting the problem situations within the context	C-1
	Referring examples and statements related with daily lives	C-2
	Asking students to give examples from their daily and professional lives	C-3
	Interpreting the data in a wider context news or articles	C-4
	Informing students about the importance of their professional lives	C-5
	Benefit from the technology to data analysis and conceptual understanding	C-6
	Give students homework, project etc.	C-7
	Making connections between different subjects	C-8
	Informing students about how they apply statistical terminology on encountered context	C-9
	Emphasize the changes on data	C-10
	Draw attention to the variation concept	C-11
	Referring context based on reasoning	C-12
	Refer possible mistakes, misconceptions, and bias	C-13