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Abstract

The present study aimed to investigate the statistical literacy perceptions of instructors who teach undergraduate statistics courses in different disciplines. Participants of the study were consisted of nine instructors of the introductory statistics course from nine different undergraduate programs. Data were collected by the help of the interviews. Instructors were asked to answer the questions about statistical literacy definitions, organization of the course content, *issues* emphasized or avoided by instructors in teaching statistics, *and* instructors‟ post-course expectations from their students. Qualitative data was categorized under five main themes based on the interview questions and data was analyzed through statistical literacy components and their aspects. The instructors' ultimate expectations from the students and the issues they emphasized during the courses are mostly stated in relation with statistical literacy. They provided less information related statistical literacy about two themes: course content and the issues they avoid. Recommendations from this study include reviewing and revising statistics course content and methods to reveal the components of statistical literacy.

Introduction

Developments in science and technology necessarily require training of individuals who can deal with the current developments. In today's ever changing and developing society, information literacy has become a must for all individuals. For example, individuals need to have knowledge about mathematics and media so that they can follow current developments directly related to their lives (Kurudayıoğlu & Tüzel, 2010). As in the case of other fields, literacy has become an important element for statistics education. Parallel with this importance, the term of statistical literacy has been prominent in statistics education (Franklin et. al., 2007; Mittag, 2010).

Ben-Zvi and Garfield (2008) point out that researchers and educators ascribe greater significance to statistics and statistics education than in the past. Thus, individuals are expected to develop meaningful perspectives and to make effective interpretations concerning events and data encountered in their daily lives (Franklin et. al., 2007; Mittag, 2010). Utomo (2021) points out that the importance of statistics in everyday life leads to increased attention on statistical literacy. Ben-Zvi, Gravemeijer and Ainley (2018) also underlined that one of the ultimate goals of the statistics education is to educate critically thinking and statistically literate citizens.

Societies aimed to promote statistical literacy skills of individuals emphasize this topic in mathematics teaching programs. In developed countries, statistics is taught as a school subject starting from elementary education onward through undergraduate programs (Ben-Zvi & Garfield, 2008; Greer, 2000; Reston, 2005). Reston (2005) draws attention to the need for further research on the multidimensional and dynamic nature of statistical literacy and the instructional difficulties in the complex nature of statistical literacy in undergraduate education. Reston (2005) investigated the level of statistical literacy of 56 graduate students enrolled in basic graduate statistics for education students. The results of the study showed that students performed relatively poor performance. Reston stressed that this poor performance was an "eye-opener" on students" deficiencies and a reflection of their need to learn more. Further, Reston pointed out that there is a need to future research along this area at graduate education and stressed that most teachers are still ill-equipped to support the incorporation of statistical literacy. Reston also stated that instructors play an important role in the development of students' statistical literacy and research towards this aim will help them deal with students" challenges and design their statistics course content effectively. In their study, Pérez-Echeverría, Postigo and Marín (2018) aimed to answer how university students understand the graphs and students" knowledge regarding content and their statistical training influence this understanding. 91 undergraduate students enrolled in two different departments (economics and psychology) took part in the study. Although it was reported few differences between two groups, Pérez-Echeverría, Postigo and Marín (2018) point out that students" performance is not suitable to enable them to read the beyond data. Also, they draw attention to the importance of the instruction on statistics as emphasizing necessary aspects should be prompted.

The Purpose of the Study

Parallel to the importance of the integrating statistical literacy in statistics courses, the present study aimed to investigate the statistical literacy perceptions of instructors who teach undergraduate statistics courses in different disciplines. To raise statistically literate citizens, it is important to investigate that how statistics is thought in schools and universities at different levels and disciplines. Also, it is important to enable students to raise their statistical literacy skills throughout their education. Instructors" tendency or willingness is also important in developing statistical literacy. The present study seeks an answer to the following research question:

How do instructors in different disciplines perceive statistical literacy?

Theoretical Framework

Statistical Literacy

Researchers focused on a variety of aspects in their statistical literacy definitions (Garfield & Ben-Zvi, 2008; Garfield & delMas, 2010). Wallman (1993) defines statistical literacy as "the ability to understand and critically evaluate statistical results that permeate our daily lives, coupled with the ability to appreciate the contributions that statistical thinking can make in public and private." (p. 1). For Garfield (1999), statistical literacy requires understanding statistical language, interpreting tables and graphs, and reading and making sense of statistics in the news, media, and daily life. In GAISE report (Aliaga et. al, 2005), the statistical literacy is defined as "the

basic knowledge of statistics (such as knowing what statistical terms and symbols mean and being able to read statistical graphs) and fundamental ideas of statistics) ". On the other hand, in statistical literacy definition Gal (2002) refers to two interrelated components: (a) ability to interpret and critically evaluate statistical information, data-related arguments, which they may encounter in diverse contexts, (b) ability to discuss or communicate statistical information, such as understanding of the meaning of the information, or concerns regarding the acceptability of given conclusions. To sum up, statistics literacy is interpreting tables and graphs, making inferences based on data, making effective decisions, adopting a critical perspective, understanding the language of statistics (words, terms, and symbols), and evaluating and interpreting data about different contexts.

Statistical literacy is an important goal of statistics education for all educational levels (Reston, 2005), and researchers underline the need for improving the statistical literacy levels of students (Franklin et. al, 2007; Gal, 2002). Chance (2002) noted that the reforms of statistics education should be guided towards the goal of raising individuals who are informed consumers of statistics. Long (1998) argued that teachers fail to achieve adequate levels of statistical literacy, which had been emphasized as a fundamental requirement of statistics, even though mathematics curriculum implemented at the schools was revised in line with NCTM standards. Similarly, according to Long (1998), learning environments and the content of the teacher training programs should be designed to include statistical literacy and graduate teachers should be equipped with necessary skills. In their study Engledowl and Tarr (2020) aimed to investigate that what knowledge structures nine middle level and secondary mathematics teachers have knowledge regarding center, spread, shape of distributions, and support their statistical reasoning. They stressed that teachers need opportunities to develop a fuller understanding of statistical concepts. Also, they pointed out that many teachers do not feel prepared to teach the statistics content required of them despites the calls for statistical literacy. They suggested that teacher professional learning programs focused on statistics would provide more opportunities for teachers to be able to teach statistics content required of them. Ben-Zvi and Garfield (2004) suggested that individuals' statistical thinking, reasoning, and literacy skills should be enhanced instead of focusing on formal knowledge, rules, formulas, and certain quantitative analysis methods. Also, Wild, Utts, and Horton (2018) underlined that students never use statistical procedures in their professional lives. Moreover, they stated that students should be able to cope with data and statistical information when necessary, in their personal lives to make informed decisions. Therefore, it is critical to investigate statistical literacy with particular emphasis on the extent to which statistics is covered in course content and to which instructors equip students with the knowledge necessary for their professional lives.

Rumsey (2002) noted two overarching goals for introductory statistics courses. First, courses should help students to become good statistical citizens, understanding statistics well enough to consume the information that permeates their lives, to approach it critically, and to make sound decisions based on that information. Second, these courses should develop scientists‟ research skills. Rumsey‟s first goal refers to developing an understanding of the statistical concepts, adopting critical thinking, and taking effective measures, i.e., raising individuals equipped with statistical skills. The second goal, on the other hand, is to develop scientific research skills. According to the objectives established for statistics courses, the students are expected to make inferences from data, gain a critical perspective, evaluate, and make decisions concerning daily situations. Such

expectations necessitate statistical literacy as a pre-requisite. At this point, raising individuals with statistical literacy emerges as an important goal.

Doehler, Taylor and Smith (2013) investigated to understand the role of statistics in teaching and research by faculty from all disciplines and their perceptions of the statistical preparation of their students. They administered a survey to 747 faculty members from seven colleges and universities regarding the use of statistics in teaching and research with undergraduate students. In their survey they asked general multiple choices items and only final item is open-ended. By the final item, they asked participants to write their suggestions to better prepare students by using statistics in their discipline. They drew attention to the research related to faculty needs and perceptions of statistics. They suggested that future studies would further enhance the understanding of how faculty view statistics and its usefulness. In this way it is important that there is a need to picture statistics courses in terms of statistical literacy.

Statistical Literacy Models

Extensive coverage of definitions and models for statistical literacy in the related literature stress the increasing importance of statistical literacy (Gal, 2002; Özmen, 2015; Watson, 1997, 2006). In her model, Watson (1997) defined a three-tiered hierarchy for statistical literacy: (1) a *basic understanding of statistical terminology*, (2) u*nderstanding language and concepts in a wider context and social discussion*, and *(3) displaying a questioning attitude.* On the other hand, Gal (2002) developed a statistical literacy model for adults and focused on two components: *knowledge* and *dispositional elements*. Knowledge elements consist of literacy skills, mathematical, statistical and context knowledge, and critical questions. Dispositional elements consist of critical attitudes and beliefs. Watson (2006) revised her previous model and gave place to mathematics-statistics knowledge, motivation, task format, variation, statistical process, and context components.

Synthesizing Watson's and Gal's models, Özmen (2015) has developed a statistical literacy model based on four components: (1) *statistical process, (2) reasoning, (3) basic concepts,* and (4) *context*. Özmen (2015) investigated how statistics teaching serves statistical literacy and students‟ statistical literacy skills at undergraduate level based on this theoretical framework. Present study, it is aimed to analyze the statistical literacy perceptions of instructors teaching statistics in different disciplines. In order to analyze the perceptions of the instructors‟ statistics teaching, it is needed to explain instructors‟ perceptions based on the statistical literacy. In this way, it is also important to explain and reflect the instructors‟ statistics instruction in terms of the statistical literacy components which play an important role on the difference in instructions‟ statistics course design. Consequently, the Özmen (2015) model was preferred in the present study since a theoretical framework was structured for statistics courses at undergraduate level and it was a synthesis of the models in the literature. Also, this model presents an analysis structure for the interview protocol with the instructors. Components of this model are summarized below:

Statistical process requires knowledge about formulation the questions, sample selection, data collection, analysis, and representation, interpretation of tables and graphs, discussion of the obtained results within the

context aspects, which are interrelated with each other. This component depicts statistical process as a process surrounded by an investigative cycle, requiring research-based skills.

Reasoning is about looking at data with a different point of view. In other words, it requires inferring from data, making evaluations based on it, thinking critically, and deciding on appropriate methods. Therefore, this component is mostly related with interpreting and critical thinking skills.

Basic concepts is related with the statistical language and terminology. It requires talking about the meaning of the statistical concepts, expressing the statistical terms with one‟s own sentences, adopting the statistical language and terminology, and explaining the relationship between statistical concepts aspects. Therefore, it is related to the basic understanding of the statistical concepts and terminology.

Context is mainly about associating statistical knowledge with the real-life situations. It includes relating to daily life situations, combining statistical and context knowledge, and interpreting the data in articles, newspapers, or magazines. Therefore, the context component requires both context and statistical knowledge.

Methods

Through a qualitative design, the present study aimed to investigate the statistical literacy perceptions of instructors in terms of the four components of Özmen (2015) statistical literacy model. The participants of the study consisted of nine instructors teaching undergraduate statistics courses in different disciplines. To seek their perceptions of statistical literacy, semi-structured interviews were carried out. Qualitative data obtained from these interviews were analyzed through qualitative analysis.

Participants

The participants of the study consisted of nine instructors teaching undergraduate statistics courses at different disciplines (general medicine (GM), geological engineering (GE), forest industry engineering (FIE), elementary school mathematics teaching (EMT), consulting and psychological counseling (CP), secondary school mathematics teaching - department of mathematics (MT), department of biology (BIO), urban and regional planning (URP), labor economy and industrial relations (LEIR)) in a state university. They had been teaching statistics for several years at their departments in the university. Instructors were informed about the present study and were asked whether they want to participate. All instructors accepted to participate voluntarily interview protocols about their prerequisites related to statistics teaching. Their majors were not actually pure statistics, but they were somewhat experts about the applications of statistics in their fields. The purpose of selecting these instructors from different disciplines is to clarify how perceptions of statistical literacy differ through varying professions and depict a diverse picture of the components of statistical literacy emphasized in statistics courses. Demographic information of the participants of the study is presented in Table 1.

Table 1. Demographic Information about the Participants

Instructor	Gender	Undergraduate Program
GM	Female	General Medicine
GE	Male	Geological Engineering
FIE	Male	Forest Industry Engineering
EMT	Male	Elementary School Mathematics Teaching
CP	Male	Consulting and Psychological Counseling
MT	Male	Secondary School Mathematics-Mathematics
BIO	Male	Department of Biology
URP	Female	Urban and Regional Planning
LEIR	Male	Labor Economy and Industrial Relations

Data Collection Tools

Semi-structured interviews were conducted with the instructors. Interviews were conducted by one of the authors of this paper. Interviews were recorded. Necessary permissions were taken for typing the interview protocol to prevent the missing data. Before starting the interviews detailed information was explained about the study. The interviews, in which the interviewer sets up a general structure and the more detailed is left to the flow of the interview, were preferred. Also, in these interviews, the interviewee has freedom as regards what to talk about and how to express it. During the interview protocol process, questions related their perceptions of statistics teaching were asked to instructors. If there is anything unfair for their understanding, detailed information was given about the questions. Interviews took 15-20 minutes. During the interviews based on the opinions of the instructors, researcher asked about all incoherent situations outright. And instructors were asked to give more details for these situations. Interviews were recorded to ensure all important data is captured, and later they were transcribed. The following interview questions were asked:

- How do you define literacy and statistical literacy?
- How do you organize the content of statistics courses? How do determine the scope and content of your statistics courses?
- What do you focus on in your introductory statistics courses?
- What issues do you avoid giving place in your introductory statistics courses?
- What do you expect your students to achieve after the introductory statistics courses are completed?

These questions were used to start conversation on statistical literacy and to explore the statistical literacy perceptions of instructors with regard to the four components of statistical literacy. Due to statistical literacy is defined as an ultimate goal of the statistics education (Franklin et. al, 2007), it is also important to picture how the perceptions of the instructors are related with statistical literacy. In other words, it is wanted to reveal whether prerequisites of the instructors are related with statistical literacy while designing their introductory statistics courses. Therefore, questions related perceptions of the instructors were examined through the

statistical literacy components and aspects. When necessary, extra questions were used during the interview process to probe into the participant‟s responses. How the participants define statistical literacy, how they organize their course content, what issues they emphasize or avoid during the courses, and what they expect from the students were discussed during the interviews. This procedure intended to reveal the extent of the role of statistical literacy in designing their courses, statistics courses themselves, and their aftermath. The analysis was limited to the responses participants provided to the interview questions.

Data Analysis

Qualitative data gathered from interviews were analyzed and categorized under five main themes: statistical literacy definitions, organizing course content, issues emphasized or avoided by instructors, post-course expectations from their students. These themes emerged from the interview questions. Additionally, data for each main theme were analyzed with reference to the statistical literacy components and their aspects of Özmen (2015) model. Firstly, statistical literacy perceptions of instructors were coded according to the specific main themes-these themes were statistical literacy definitions, expectations from students, designing the course, issues emphasized or avoided, and they were also based on the interview questions formed through the discussion and negotiation process between authors. Statistical literacy components and their aspects were based on while determining the themes. After instructors‟ answers for the questions are transcribed, remarkable points or main ideas were determined, and they are analyzed through the statistical literacy aspects. For example, if instructors emphasize the statistical process in their answer, their statements are also analyzed through the procedure that which aspects of the statistical process are they related. Even though the data was categorized based on the answers for the related questions, if a statement pertaining to a given category was observed in the response to another question, it was categorized under the relevant themes. Coding was continued after two authors had a consensus on the related themes. For instance, GM instructor stated the following, explaining the issues she emphasized during the courses:

> *What do we take into account? We expect them to know how to read, to interpret, and to use the statistical result in clinical settings, rather than to make calculations, to utilize the evidence thus gathered in medicine, and to understand its meaning. But the utmost expectation we have is the ability to understand the meaning of the result. I attach importance to their capability of perceiving under which circumstances the results can be employed.*

Such a statement was summarized under the interpretation of the results (statistical process), demonstration of the ability to utilize them at their work (context), generalization of the results (reasoning), and rationalization of the results (reasoning) aspects. Thus, instructors‟ answers for each question were analyzed whether it was related with statistical literacy components. After, it was determined that which aspects these answers are related (for example, if an answer is related statistical process above, it was also coded with more specific sub-themes such as interpreting the results, interpreting the table and graphs, gathering data from the class etc.). Thus, not only instructors‟ answers were interrelated with statistical literacy but also these answers were analyzed through more specific themes or aspects. Therefore, all answers of instructors were examined in terms of main themes, statistical literacy components and its aspects. All data were analyzed through this procedure, sub-themes were

categorized under the related main themes. Participants who presented similar theme and sub-themes were also noted. Due to purpose of the study is investigating the statistical literacy perceptions of the instructors, it has qualitative nature. Therefore, data were analyzed qualitatively. And themes and sub themes that instructors more emphasized or ignored out are taken into consideration rather than frequencies.

Findings

Present study aimed to answer the research question as "*How do instructors in different disciplines perceive statistical literacy?* ". This section presents the instructors' perceptions of statistical literacy and reveals how these perceptions shaped course contents, approaches, and the expectations, with reference to the components of Özmen (2015) statistical literacy model. Statistical literacy perceptions of instructors were categorized under five themes: definition, post-course expectations, contents of the course, issues avoided, and issues emphasized during statistics teaching.

Findings about the Instructors' Statistical Literacy Definitions

The themes observed as to the statistical literacy definitions of instructors are summarized in this section. Table 2 describes the themes about statistical literacy definitions of instructors.

Table 2. Themes Concerning Statistical Literacy Definitions

Theme	Component	Instructor
Interpreting the table and graphs	Statistical Process	EMT, BIO, FIE, GM
A statistical process		EMT, FIE
Data categorization		FIE
Assessment-inference	Reasoning	EMT, BIO
Decide on the applicable method		CP
Understanding the concepts	Basic Concepts	EMT, FIE, GM
Terminology		EMT, URP, FIE
Daily life	Context	GE, LEIR, FIE, GM

As can be seen in Table 2, interpreting table and graphs and daily life aspects were seen as the most essential components of statistical literacy definitions of instructors. Similarly, these aspects are referred to statistical literacy definitions in the literature (Aliaga et al., 2005; Garfield, 1999). On the other hand, data categorization and selection of the applicable method aspects were less represented in statistical literacy definitions. FIE and EMT instructors mentioned different aspects in their statistical literacy definitions. Especially, the EMT instructor defined statistical literacy in a wider context by focusing on all the statistical literacy components:

> *It is the ability of the individuals to employ concepts of statistics. It is not only employing the concepts but also adopting symbols related to statistics. Moreover, being able to infer from the statistical formula presented. It is an ability to establish the relationship between statistical processes. In other words, it is*

the ability to interpret a graph, or build a graph with reference to an interpretation, or should I say, the ability to apply processes in reverse are also aspects of statistical literacy.

The EMT instructor defined statistical literacy in a wider context and underlined the knowledge of fundamental concepts and terminology, and the ability to make inferences, to interpret tables and graphs, and to apply the statistical process aspects, which can be explained by the fact that this instructor was at the same time teaching a statistical course at graduate level. Indeed, EMT instructor‟s awareness about statistical literacy and its aspects and his transference of it to teaching seemed to be effective. Moreover, the EMT instructor studied mathematics and statistics education, which could also account for his awareness. On the other hand, GE, URP, and CP instructors mentioned only one aspect in their definitions. This shows that these instructors make sense of statistical literacy in a limited structure. Since the MEM instructor defined statistical literacy as talking about the numbers. Therefore, his definition was not enough to associate with statistical literacy and its aspects.

Findings about the Organization of the Course Content

The themes observed with reference to instructors' organization of the course content is summarized in this section. Table 3 describes the themes with reference to instructors‟ organization of the course content.

Table 3. Themes Concerning Organization of Course Content

Theme	Component	Instructor
Critical thinking	Reasoning	EMT, LEIR
No specific emphasis in mathematics	Basic Concepts	LEIR, FIE
Discussing all topics		FIE, MT, BIO
Falling short of discussing all topics		EMT
Daily life	Context	EMT, GE
Professional life		BIO, GM, CP, URP, FIE, LEIR

Table 3 shows that instructors did not mention any aspect of the statistical process component in organization of their course content. In other words, they have made no special emphasis on designing their course content to develop statistical process skills of students. That is, while organizing the course content, the instructors have not considered, as a primary goal, equipping students with research process skills, which was indicated as a critical skill by Rumsey (2002). It is evident that instructors organize course contents mostly based on the aspect of professional life as mentioned in GAISE reports (Aliaga et al., 2005; Franklin et. al, 2007). For instance, the LEIR instructor stated the following:

I try to discuss in more detail those issues which I think is to be helpful in developing thinking capabilities and critical thinking of the students. As I said, statistics is a quantitative course, but it does not require a solely quantitative perspective unlike mathematics. What are the issues that students can

use in the field of economics? We try to focus on issues concerning mostly the field of economics. For instance, index numbers, regression, and correlation…

The LEIR instructor gives priority to particular topics associated with their professions and avoids getting mired down in mathematics. Thus, he tries to organize his course content to develop students‟ critical thinking necessary in the field of economics. It seems that other aspects were under-represented by the instructors. To illustrate, inadequacy in discussing all subjects was only indicated by the EMT instructor. Similarly, no specific emphasis was placed on critical thinking in mathematics, and daily life aspects were less considered in organizing their course content. About their course content organization, FIE, LEIR, and EMT instructors referred to aspects that are different from other participants. This could be attributed to their students who are admitted to FIE and LEIR programs with lower scores from the national university entrance exam. Because their mathematical achievement is lower, these instructors might have to consider more aspects in their course content organization. On the other hand, the EMT instructor prefers daily life practices rather than theoretical knowledge in his statistics course and defines statistical literacy in a wider context. Similarly, GE, MT, GM, and CP instructors keep away from theoretical knowledge as much as possible, trying to organize simpler course contents and paying attention to daily or professional life practices.

Findings about the Issues Emphasized by Instructors in Teaching Statistics

In this section, the themes observed with reference to the issues emphasized by instructors are summarized in Table 4.

Table 4. Themes Concerning the Issues Emphasized in Statistics Courses

Theme	Component	Instructor
Interpreting the results	Statistical Process	GE, GM
Gathering data from the class		EMT
Assessment-inference	Reasoning	EMT, GM, URP EMT GE EMT
Revealing the foundation of formula		
Deciding on the applicable method		
Balance in procedural-conceptual knowledge		
Specific emphasis on meaning of concepts Terminology	Basic Concepts	URP
Daily and professional life	Context	URP, GM, LEIR, CP, FIE
Combining terminology with context		BIO, EMT
Use of technology		EMT, GM

Instructors deal with statistical topics that are commonly emphasized in daily and professional life. That is, daily and professional life aspects are important for the instructors to consider in forming their course content. Putting special emphasis on the association of statistical concepts with daily and professional life, instructors draw students‟ attention to these aspects in their lessons. Other aspects, however, may be under-represented. Instructors‟ placing greater emphasis on the importance of the daily and professional life situations could lead to ignorance of other aspects. It was the EMT instructor who brought up specific themes about the issues emphasized in his course. On the other hand, FIE, BIO, LEIR, and CP instructors mentioned only one issue while discussing the same prompt. Due to MT instructor‟s explanations was not directly related to statistical literacy and its aspects in this category, the statement of "MT" is not given in Table 4. The MT instructor underlined that he tries to give importance to increasing the motivation of the students and expected them to bring calculators, thinking that calculations is a major component of the course content. Clearly, this emphasis is not related to statistics literacy. The GM instructor highlighted more relevant points to describe what she emphasizes in statistics courses:

> *The points we try to emphasize... We try to make them able to know how to read, interpret, and use the statistical results in clinical settings, rather than to make calculations. And we try to train them to be aware of the evidence level in medicine, and to understand its meaning. But most importantly, students should understand the meaning of the obtained result within the context. I try to consider whether students could choose appropriate methods and evaluate.*

For the GM instructor, particular emphasis should be on the interpretation of the result and comprehension of what a specific result means professionally. On the other hand, the URP instructor explained about what she emphasizes in statistics courses as follows:

> *Actually, it is about raising awareness. Numbers are all around our lives, but they get meaning only when combined. It is raising statistical literacy. But while doing that, we must associate it with the professional or daily life. I find it important to help them understand a discussion they hear, or they read, or to make inferences based on the analyses. Furthermore, when we say accessories, we think of green fields of sports, or school grounds professionally. For an architect, on the other hand, it means armchairs or chairs. When you mention 'frequency' as a statistics term, it has a specific meaning. However, someone else may think of radio frequencies. In order to adopt the terminology, students must know and understand the basic concepts.*

It is evident here that the URP instructor tries to improve the statistical literacy levels of her students and to link statistics with their daily and professional lives in particular. Furthermore, she also emphasizes a general grasp of terminology, an awareness of fundamental issues, and an understanding of inferences as.

Findings about the Issues Avoided by Instructors in Teaching Statistics

The themes that emerged with reference to the issues avoided by instructors are summarized in this section. Table 5 describes the themes with reference to the points avoided by instructors.

Table 5. Themes Concerning Issues Avoided in Statistics Courses

Theme	Component	Instructor
Offensive data gathering procedures in class	Statistical Process	EMT
Mathematical operations	Reasoning	GM, FIE, GE, LEIR, EMT
Procedural approach		EMT
Revealing the foundation of formula		CP, BIO, FIE
Giving details	Basic Concepts	LEIR, BIO, GM
Basic subjects		EMT
Cases which are not relevant to the field	Context	URP, GM

The participants did not refer to statistical literacy and its components much when discussing the issues, they avoided in their courses. Still, the mathematical operations aspect was most frequently represented under this theme. Revealing the source of the formula and provision of details followed this one. The instructors indicated that they try to keep away from procedures, rules, and calculations in their lessons. Other aspects that the instructors do not opt for teaching were indicated with lower frequency. The URP, GE, and CP instructors mentioned only one issue to be avoided in their courses. MT instructor said that he tries to avoid hurting students‟ love for statistics. Being irrelevant, it was not given in the table. The GM instructor explained what she avoided in her courses as follows:

> *Calculations or details require so much time and effort. We are careful with that. I try to avoid calculations. For example, last year we would show how to make calculations, but this year, we did not go that way. I can always look up these calculations when it is necessary. I do not know all the details by heart. Should the students know? That is why we avoided points which are not related with medicine. The important thing is to be able to look it up and use if it is necessary. Therefore, we did not give calculation in a detailed way.*

As can be seen in this quotation, the GM instructor did not prefer to give place to calculations or details and to stress mathematics and topics which are not directly related to their field. She underlined the importance of using field-related knowledge. On the other hand, the EMT instructor pointed out the following while explaining what he excludes from his lessons:

> *I skip basic subjects quickly compared to other disciplines. I believe that students have a certain level of competence in basic subjects. I make a quick revision of these subjects if it is relevant. But I do not spend much time on it anyway. I avoid discussing details of procedural knowledge as much as possible. Of course, I ask them to handle operations, but I try to present it within a conceptual framework. I am also careful about one issue, even though this does not always work. I try to find non-offending examples when gathering data from the class. You could cause students to be offended in the classroom environment. For example, sometimes when you ask girls their height, they may be offended.*

It seems that the EMT instructor does not prefer to discuss basic subjects extensively in his lessons. He also does not make a special effort for more familiar subjects and concepts. Additionally, he tries to keep the procedural knowledge perspectives out of the scope of his courses as much as possible. Finally, he makes an effort to avoid using examples which could offend students when asking for data from statistics classes.

Findings about the Instructors Post-Course Expectations from Their Students

The instructors' perceptions regarding statistical literacy were found to congregate mostly around what the students are expected to achieve at the completion of the statistics course. The themes related the instructors‟ expectations from students are summarized in this section. Table 6 describes the themes pertaining to the instructors‟ post-course expectations from their students.

Table 6. Themes Concerning the Instructors' Post-Course Expectations

Theme	Component	Instructor
A robust grasp of sampling	Statistical Process	LEIR, FIE, GE
Data categorization		FIE, CP
Contextual interpretation of results		GM
Interpretation of tables and graphs		EMT, FIE
Appropriate data collection		CP
Assessment-inference	Reasoning	EMT, GE
Awareness about the foundation of formulas		EMT
Selection of applicable methods		EMT, GE, FIE, GM, LEIR, MT
Scientific proof-generalization		EMT, GM, CP
Understanding of the meaning of concepts	Basic Concepts	GM, FIE
Explaining the relationships between concepts		CP
Adoption of terminology		MT, URP
Transferring knowledge to professional life	Context	BIO, URP, CP, GM, FIE
Combining terminology with the context		BIO
Transferring knowledge to daily life		LEIR, FIE, EMT, MT
Being aware of possible errors and mistakes		EMT, CP
Interpreting the data in articles		GM
Expressing the variation		EMT

The instructors' expectations from the students are mostly about the context component, while the basic concepts component is focused on the least. As regards their post-course expectations from students, deciding on the applicable method and transferring knowledge to professional and daily life aspects were most frequently represented by the instructors. They pay attention to the application of the statistics on daily and professional life situations and emphasize these aspects in their course contents. Therefore, explaining their expectations from students, they mostly refer to the aspects related to the context component. However, as diverse methods

and formulas are parallel to the diverse nature of contexts, the data yielded difficulties about how the problems can be solved or which methods can be used. That is, instructors could have expectations from students to be able to decide on the applicable method. Besides, understanding the basic concepts and adopting the statistical terminology are the main objectives not only in statistics but also in many other fields. Therefore, instructors may refer to aspects related to basic concepts less frequently than other components. Likewise, interpreting the results in relation with the context, gathering appropriate data, gaining awareness about the foundation of formulas, explaining the relationships between concepts, combining terminology with context, interpreting articles, and expressing variation aspects were less frequently represented by the instructors. The EMT and FIE instructors‟ responses shed varied light onto the expectations from students. On the other hand, BIO and URP instructors revealed fewer details about expectations from students. The MT instructor stated the following about the post-course expectations:

> *When students have met a concept, they should think that 'I remember this concept, the arithmetic mean'. They could transfer their knowledge in these situations. That is the point where theoretical knowledge is transferred into practice. When the students have met a probability or statistics problem, they should know where they could look and where they could find similar problems and solutions. She may not always remember the Poisson distribution completely, but she should be aware of the fact that relevant information about Poisson distribution is available in probability-statistics books.*

The MT instructor stressed the importance of knowing the concepts and their connection with probability or statistics. He pointed out that students could not be aware of the meaning of such concepts completely. Furthermore, he stated that he expected students to practically transfer their knowledge to their daily and professional life. The CP instructor, in turn, noted his post-course expectations as follows:

> *We mostly expect them to gather data by adopting a scientific perspective, to summarize their data appropriately, to display the obtained results through relevant analyses, to determine scientific judgments. Of course, I expect them to act with a systematical perspective when they engage in an issue. Any information should be based on data or obtained through an appropriate method, or else it should always be doubted. They should notice this kind of information. I believe that relational techniques are crucial when we explain the complexity of behaviors. I think awareness about this is crucial. I mean, when we think of behaviors as a variable, they are always interacting; our goal is trying to understand this, trying to reveal the relationships. If we learn and understand this mechanism, we can achieve our goal of revealing the relations or predictors.*

For the CP instructor, students should be able to classify data systematically and know the data gathering methods. He points out the importance of behavioral research in their profession. He stresses the importance of students‟ ability to explain the relations between concepts. Furthermore, he clearly expects students to develop a skeptical perspective towards inappropriate methods or explanations. The GM instructor's expectations, on the other hand, embrace further components of statistical literacy. She explained her post-course expectations as follows:

> *The students should be aware of which method to use, where, and when. Also, they should know how to interpret the significant differences between the results. That is why I make them repeat hypotheses again*

and again, just like a rhyme. What was it, is that it? If students do not make hypothesis sentences, they cannot understand what these results mean. Significant or insignificant difference, that is not enough. Or the research assistant may come for dissertation ideas and may ask the calculation of a p value. Which p value do you refer to? What does it mean, what is its use? I want the students to know these. What do the results mean and show for the clinical setting? What is the evidence level of these results? I mean, what level of confidence should we have within the evidence pyramid? Because there is a concept called evidence-based medicine in medical sciences. And also, technology is moving fast. There are many publications. Some note that there are 6000 papers published each month in medical sciences. It is impossible that people could follow all these publications. Therefore, they could understand which papers are more useful and valuable for them. They should be able to read and interpret what these obtained results actually mean.

As can be seen here, the GM instructor attaches importance to the students' ability to understand the meaning and to interpret results, regarding the existence or lack of an effect. The instructor emphasizes the clinical significance of the finding, and the confidence level of such findings would instill, on the basis of the level of evidence set in the research. Being aware of the meaning of concepts and how and where to use them are crucial for the GM instructor. Furthermore, she emphasizes the need to approach the publications selectively according to two criteria: significance to the reader and the reliability of the findings. She draws attention to the high number of the medicine papers, more than 6000, published each month and to the need for the students to internalize the recent developments. A review of the instructors' statistical literacy expectations points to the fact that they give importance to post-course expectations and statistical literacy components directly taught in their courses. Other salient findings were about organization of the course content and issues avoided during teaching. The findings as regards the statistical literacy perceptions manifested that context, reasoning, and basic concepts are significant.

Discussion and Conclusion

The statistical literacy perceptions of statistics instructors in different disciplines were pictured with reference to definitions, expectations, issues emphasized and avoided, and the course contents. The main themes related to statistical literacy definitions were the ability to interpret table and graphs, transfer knowledge to daily and professional life situations, and understand the terminology of statistics. The meanings instructors ascribe to statistical literacy were found to be in accordance with the literature. Transferring knowledge to daily life situations (Garfield, 1999; Wallman, 1993), understanding of the statistical language and terminology (Aliaga et. al, 2005; Garfield, 1999), and interpreting tables and graphs (Aliaga et. al, 2005; Garfield, 1999) are among the competences that literature refers to commonly. Nevertheless, even though critical thinking is regarded as an important element of the statistical literacy (Gal, 2002; Garfield, 1999; Wallman, 1993; Watson, 1997, 2006), the participants of the present study did not refer to this aspect in their definitions. This might suggest that critical thinking is not practiced during the courses. Alternatively, the instructors might have failed to include it in their statistical literacy definitions EMT and LEIR instructors referred to critical thinking while explaining their approach to course content demonstrating the importance, they give to it as part of statistics courses.

The instructors' statistical literacy definitions concentrated in certain aspects of the statistical literacy components. For instance, the statistical process component is often discussed with reference to interpreting tables and graphs, categorizing data, and interpreting the results according to the context. Reasoning component, on the other hand, is about the aspects of assessment-inference and determining the applicable method. The themes related to basic concepts less frequently emerged. However, the participants made references to awareness of the meaning of concepts and terminology as to this component. The context component, on the other hand, was concerned with the daily and professional life aspects.

The instructors' ultimate expectations from the students and the issues they emphasized during the courses are mostly stated in relation with statistical literacy. On the other hand, instructors did not underline statistical literacy when they were elaborating on their course content design and the avoided issues in their courses. Guven, Baki, Uzun, Ozmen, and Arslan (2021) stressed that regardless of the grade level, the importance of statistics courses became remarkable in raising students statistically literate. They also pointed out that instructors have an important role in designing the course content through recommendations. Also, it is concluded that instructors mostly associated the issues emphasized in statistics courses and the post-course expectations from students with statistical literacy. The growing need to train statistically literate undergraduate students (Bakker, 2004; Gal, 2002; Mittag 2010; Wallman, 1993; Watson & Moritz, 2000) may account for the greater emphasis placed on statistical literacy in post-course expectations. However, as statistical literacy is not considered important in designing the course content, the probability of realizing these expectations is questionable. Furthermore, incorporating statistical literacy in statistics courses (Ben-Zvi & Garfield, 2004; Guven, Baki, Uzun, Ozmen, & Arslan, 2021; Hassad, 2007; Rumsey, 2002; Schield, 2004) and dealing with the challenge of incorporating statistical literacy into the graduate education curriculum are suggested (Reston, 2005). Thus, it is crucial for the instructors to pay special attention to the objective of raising individuals equipped with necessary skills and aspects during the statistics courses (Guven, Baki, Uzun, Ozmen, & Arslan 2021; Özmen, 2015; Pérez-Echeverría, Postigo, & Marín, 2018; Reston, 2005). Doehler, Taylor, and Smith (2013) pointed out that instructors mostly stressed the importance of increasing statistical literacy levels of students to better prepare them for using statistics in their disciplines and to truly engage them with statistics. To this end, the topics included in the course content, the educational approach, and instructional methods may be arranged to develop statistical literacy and promote understanding of its aspects.

As a response to the interview question about the issues emphasized, the participants mostly referred to the aspects of daily and professional life. This showed that instructors paid attention to students' ability to transfer theoretical knowledge to daily and professional life situations. Furthermore, the instructors' perceptions of statistical literacy have centered on context and reasoning components, while the basic concepts component is not much considered. The need to train graduate students as statistically literate and equipped with the critical thinking and reasoning skills might have led to the growing emphasis on these components. On the other hand, statistics includes various concepts and requires much more theoretical details, so the importance of the basic concepts theme emerged. However, even though raising awareness of basic concepts is a main objective of statistics courses, the failure to exert a special emphasis on this may be a restriction to its achievement. On the

other hand, Rumsey (2002) stressed two main goals for introductory statistics courses: to train citizens with statistical literacy and to develop investigative skills of students. In fact, the findings about instructors‟ priorities in their course contents in the present study did not really reflect Rumsey‟s goals. At this point, it may be advised that instructors design their course contents through the goals of training graduate students with statistical literacy and research skills.

The instructors' statements regarding the issues they avoid during the courses were more often related with the reasoning component. The instructors generally pointed out that they pay attention to avoiding mathematics-heavy or calculation-heavy approaches in their classes. These findings were parallel to the related literature in terms of the expectations from the statistics courses (Ben-Zvi & Garfield, 2004; Hassad, 2007). Indeed, the related literature also manifests the tendency to exclude calculation-or memorization- intensive cases from instruction. Similarly, the instructors' reported tendency to avoid excessive and unnecessary details when teaching a topic is in agreement with this.

The issues emphasized by the instructors in their statistics courses and their post-course expectations from students are also parallel to the aspects concerning statistical literacy. In other words, the instructors' post-course expectations from students influence which issues to emphasize in the courses. The presence of similar aspects in instructors‟ statements regarding both themes supports this finding. The instructors mostly emphasize transference to daily and professional lives, as well as performance of assessment-inference. Making assessment-inference based on data is crucial for statistical literacy, both of which are commonly marked as crucial in the related literature (Franklin et. al., 2007).

The statistical literacy perceptions of instructors differ in terms of statistical literacy components. For instance, the EMT instructor emphasizes reasoning, whereas GM and CP instructors refer to context component. The FIE instructor, on the other hand, emphasized statistical process, while the URP instructor underlined the need for an awareness of basic concepts. Besides, similarities exist in statistical literacy perceptions of instructors. Even though the programs focus on training professionals in different vocations, the instructors generally refer to transference to daily and professional life, determining the applicable methods, and avoidance of heavy calculations. It should be noted that undergraduate programs from different disciplines were within the scope of this study. Thus, implications of this study may be considered in the light of introductory statistics courses for undergraduate students. Statistics courses with the objective of developing statistics literacy and practice-based teaching techniques may be designed. Similarly, it is underlined that statistical literacy and thinking levels of students can be improved with well-planned teaching practices or activities in the literature (Callingham & Watson, 2017; Gundlach, Richards, Nelson, & Levesque-Bristol, 2015). Therefore, statistics instructors could design their courses in a way to include not only statistical knowledge but also professional knowledge, which would foster effective learning, rationalization of statistics, and the development of statistical thinking and reasoning skills.

Statistical literacy is also one of the current issues for mathematics education. The importance of raising students who are statistically literate is often emphasized. It was seen that many instructors are not knowledgeable about the statistical education communities such as ASA, which work towards preparing

guidelines for teaching statistics (e.g., GAISE report), or authors who write textbooks and offer professional development workshops for statistics instructors. Also, Doehler, Taylor and Smith (2013) stressed that it is unknown whether faculty in client disciplines are aware of this guideline. Besides, present study it could be said that instructors could not put statistical literacy at the center of their instruction. When the ultimate goal as raising students statistically literate was taken into consider it could be said that more emphasis could be given in place to statistical literacy during the statistics instructions at undergraduate level. On the other hand, present study aimed to picture the perceptions of the instructors of the statistics courses with the limited sample. Thus, it is not probable to make generalization from these claims and findings. However, it could be suggested that more emphasis on statistical literacy during the statistics teaching, would be an important attempt to raise students as statistically literate regarding the situations they encountered in their daily and professional lives.

Not only participants of this study but also many instructors who are teaching statistics at different universities and disciplines could be not informed of or willing to follow current developments in statistical literacy. Similarly, Ben-Zvi and Makar (2016) noted that many instructors find statistics courses frustrating and unrewarding to teach. Therefore, none of this effort will have an impact unless the instructors use these resources effectively. However, theoretical knowledge becomes meaningful when putting the theory into practice; these advancements would be limited to theoretical knowledge. Ben-Zvi and Makar (2016) also underlined that "despite reform efforts, many statistics courses at the university level still teach the same progression of content and emphasize the same development of skills and procedures" (p.3). They also stressed that many students end up perceiving statistics as a set of tools and techniques that are soon forgotten. To combat such perception, both instructors of statistics and field experts in statistics may work cooperatively. Furthermore, statistics education community could inform statistics instructors about different efforts such as recent developments, applications, approaches, or simulations regarding statistics education and statistical literacy. Statistics education community may better inform instructors and show them the diverse applications that enrich statistics courses and help raise statistical literacy levels of students. Finally, instructors should be willing to learn, apply, and follow whatever is new in statistics education.

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