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SPIDAS

LOCAL REPORT
TURKEY

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1. CURRICULUM OVERVIEW OF MIDDLE SCHOOL AND SECONDARY SCHOOL EDUCATION IN TURKEY

In this section we present an overview of the Turkish National Curriculum from 5th grade to 12th grade in relation to data analytics topics. We synthesise the main learning domains and learning outcomes included in the curriculum in relation to data analytics across different subject areas (mathematics, science, social studies, and geography). We also discuss the teaching approaches, including the methods and technology use, expected in the school curriculum and the percentage of hours for teaching data analytics related topics as part of the school mathematics curriculum. Finally we present main conclusions that can be drawn from the curriculum overview. The implications will lead the design of SPIDAS pilot projects.

1.1. GENERAL ASPECTS AND CONTENT STRUCTURE

"Mathematical competence and basic competencies in science and technology" is one of the eight key skills described in the Turkish National Curriculum (MEB, 2018a). Mathematical competence involves developing and applying mathematical thinking to solve a range of problems encountered in daily life. The emphasis is made on process built on a sound mastery of numeracy, activity and knowledge. Competence in science refers to the ability and willingness to use the body of knowledge and methodology in relation to explain the natural world with the aim of identifying questions and drawing evidence-based conclusions. Moreover, competence in technology is viewed as the application of knowledge and methodology in the context of satisfying the perceived human requests and needs.

Key competencies specific to mathematics are as follows: 1) problem solving and 2) mathematical process skills: communication, reasoning, mathematical modelling, connection, affective skills, psychomotor skills and information and communication technology skills (ICT).

With regard to content, the school mathematics curriculum is comprised of the following learning domains: 1) in middle school: "Numbers and Operations"; "Algebra"; "Geometry and Measurement"; "Data Handling"; "Probability" and 2) in high school: "Numbers and Algebra"; "Geometry"; "Data, Counting and Probability". SPIDAS project content is relevant to "Data Handling"; "Probability" and "Data, Counting and Probability" learning domains and will contribute to teaching of these topics with novel approaches.

1.2 CURRICULUM OVERVIEW

In this section, we provide an overview of data analytics related content in mathematics, science, social sciences and geography in middle school and high school education along with teaching methods, technology use and hours of teaching expected according to the Turkish National Curriculum (MEB, 2018a, 2018b).

1.2.1. Curriculum Overview of Middle School Education (Grades 5 to 8)

The data topics include the statistical investigation cycle, also known as PPDAC cycle consisting of five stages: Problem, Plan, Data, Analysis and Conclusion (Wild & Pfannkuch, 1999), in middle school mathematics curriculum (MEB, 2013, 2018a). In the 5th grade students (ages 10-11) are expected to formulate research questions that require data collection, to collect data (limited to one variable and discrete data), to display data with frequency table and bar graph and to interpret the results from these representations. In the 6th grade (ages 11-12) these expectations are extended to include comparing two data sets (limited to discrete data) and analysing the data using the range and arithmetic mean of a data set. In the 7th (ages 12-13) and 8th grades (ages 13-14) the emphasis is more on data analysis including representing and interpreting data using appropriate graphs (line graph, pie chart and bar graph) and calculating and interpreting the measures of central tendency (mean, median and mode). Probability is first introduced in the 8th grade and only requires understanding of probability language, equally likely outcomes, calculation of probability of simple events.

“Problem solving”, “question and answer” and “discussion” were described as the main methods of teaching and interactive board is mentioned as the main technology tool in the unit plans for mathematics in the partner middle school. Moreover, the national mathematics curriculum for middle school mentions the use of ICT tools for representing data in the 5th and 7th grades. However, the classroom observations suggest that mathematics teachers tend to use lecture and question and answer methods in their teaching of DA related topics. The use of group work is also absent. Using technology appears to be limited to the use of online resources in EBA (Education Informatics Network-nationwide online platform for sharing e-contents in every subject matter taught at all grades levels), such as course video clips and online multiple choice tests. The total amount of time spent on teaching mathematics is 180 hours at each grade level in middle school. The amount of time for teaching data and probability at each grade level varies as seen in Table 1.

Table 1. Data and probability content in middle school mathematics, including teaching methods, technology tools and amount of time for teaching

Key content	Learning objectives/Competencies	Subject (maths, science etc.)	Age/s	Teaching approach/methods	Technology tools used	Hours/Timing Aprox.
Data collection and evaluation	Students • Formulate research questions that require data collection *a) Related contexts: environmental awareness, saving, cooperation, avoid wasting etc.* • Collect data related to research questions or select relevant data; display data with frequency table and bar graph *a) Limited to one variable and discrete data* *b) Use ICT tools for organizing and representing data* • Solve problems for interpreting data displayed in frequency table and bar graph	Mathematics	10-11 (5th grade)	Problem solving; question and answer; discussion	Interactive board	10 (6%) December
Data collection	Students	Mathematics	11-12	Problem solving; question and answer; discussion	Interactive board	5 (2%) February

and evaluation	• Formulate research questions that require comparing two data sets and collect data *a) Limited to discrete data* • Represents data from two groups with dual frequency table and dual bar graph		(6th grade)			
Data analysis	Students • Calculate and interpret the range of a data set • Calculate and interpret the arithmetic mean of a data set • Use arithmetic mean and range to compare and interpret two data sets *a) Include activities for interpreting arithmetic mean and range in real life situations*	Mathematics	11-12 (6th grade)	Problem solving; question and answer; discussion	Interactive board	6 (3%) February
Data analysis	Students • Represent and interpret data using line graph *a) Include activities involving line graphs for two data sets* • Calculate and interpret the arithmetic mean, median and mode of a data set *a) Use ICT tools for understanding which one is the appropriate measure*	Mathematics	12-13 (7th grade)	Problem solving; question and answer; discussion	Interactive board	15 (8%) April

	• Represent and interpret data using pie chart *a) Use ICT tools for making pie chart* • Represent data using bar graph, pie chart or line graph and make appropriate conversions between them					
Probability of simple events	Students • Determine possible outcomes of an event • Differentiate events that are "more likely", "equally likely" and "less likely" and give examples • Explain that probability value of each equally likely outcomes of an event is equal to each other and 1/n • Understand that probability value is between 0 and 1 (including 0 and 1) • Calculate the probability of a simple event	Mathematics	13-14 (8th grade)	Problem solving; question and answer; discussion	Interactive board	12 (7%) December
Data analysis	Students • Interpret line and bar graphs of up to three data sets • Represent data using bar graph, pie chart or line graph and make conversions between them	Mathematics	13-14 (8th grade)	Problem solving; question and answer; discussion	Interactive board	12 (7%) June

Science and social sciences are the other subject areas that require data analytics skills in the middle school national curriculum. Similar to the Mathematics Curriculum, the Science Curriculum (MEB, 2018c) and the Social Sciences Curriculum (MEB, 2018d) are recently revised in light of the 21st century learning skills. As a result, both in science and social sciences students are expected to develop data/evidence-based decision-making skills as well as to make and interpret table and graphs based on data. Related learning objectives are shown in Table 2 and indicate the use of data to make decisions in various contexts. It needs to be noted that the nature of data and the use of data might differ in the implemented curriculum in classrooms. In the partner middle school, science teachers tend to use data available in EBA (Education Informatics Network-nationwide online platform for sharing e-contents in every subject matter taught at all grades levels) and textbooks and research data available in internet resources. Social sciences teachers tend to use both data available in textbooks and instant data from the Turkish Meteorology Office depending on the topic taught. As seen in Table 2, research inquiry, problem solving, discussion and brainstorming are the recommended teaching methods for science and social sciences subject matters; interactive board is the main technology used in teaching.

Table 2. Data related content in middle school science and social sciences, including teaching methods, technology tools and amount of time for teaching

Key content	Learning objectives/Competencies	Subject (maths, science etc.)	Age/s	Teaching approach/methods	Technology tools used	Hours/Timing Aprox.
Change of state of matter	Students • Make inferences based on data from experiments related to the change of state of matter due to heat	Science	10-11 (5th grade)	Research inquiry; problem solving; discussion; brainstorm	Interactive board; simulations	6
Biodiversity	Students • Discuss the factors (such as climate change) threatening biodiversity using research data	Science	10-11 (5th grade)	Research inquiry; discussion; brainstorm	Interactive board	6

Controller and regulator systems	Students should • Discuss what needs to be done to pass healthy puberty period using research data	Science	11-12 (6th grade)	Research inquiry	Interactive board	2
Health of systems in the human body	Students should • Discuss what is needed for healthy systems using research data	Science	11-12 (6th grade)	Research inquiry; discussion	Interactive board	2
Human reproduction, growth and development	Students • Discuss precautions needed for healthy development of the embryo using research data	Science	12-13 (7th grade)	Research inquiry	Interactive board	2
Sustainable development	Students • Provide solutions in relation to contribution of recycling for country economy using research data	Science	13-14 (8th grade)	Research inquiry	Interactive board	1
Interaction of matter with heath	Students • Display and interpret change of state and heath on a graph	Science	13-14 (8th grade)	Problem solving; question and answer; discussion	Interactive board	1
People, places and surroundings	Students • Make inference about climate properties based on human livings in different natural settings	Social sciences	11-12 (6th grade)	Problem solving; question and answer; discussion	Interactive board	

	(*Inferences about Mediterranean climate, polar climate, monsoon climate, and equatorial climate based on information and data related to people's livings*)					
People, places and surroundings	Students • Interpret properties of demographics of Turkey based on the factors affecting population distribution in Turkey (*Interpret data related to demographic properties using table and graphs*)	Social sciences	12-13 (7th grade)	Problem solving; question and answer; discussion	Interactive board	4 (3,7%)

1.2.2. Curriculum Overview of Secondary School Education (Grades 9-12)

The data topics were included in the high school mathematics curriculum since the revisions in 2013. Prior to that, only combinatorics and probability were taught in high school. According to the new revised curriculum (MEB, 2018b), the mathematics content in the 9th (ages 14-15) and 10th (ages 15-16) grades is the same for all students. The data topics are taught in the 9th grade and include only Analysis and Conclusion stages of PPDAC cycle (Wild & Pfannkuch, 1999), such as calculating and interpreting measures of central tendency and spread, comparing more than two data sets, representing and interpreting data using appropriate graph types, including histogram. In the 10th (ages 15-16) and 11th (ages 16-17) grades the focus is on probability from a combinatorics perspective, i.e. the study of arrangement and selection, probability of simple events, conditional probability, experimental and theoretical probability. In the 11th and 12th (ages 17-18) grades students have options to choose their mathematics course based on the programme they opt for according to their preference of study major at the university. Those who choose a programme with less mathematical content can elect basic level mathematics course in the 12th grade which includes data analysis and interpretation in solving real life problems.

The use of teaching methods and technology in teaching DA related topics at high school level is not very different than the ones at the middle school level. “Problem solving”, “question and answer” and “discussion” were described as the main methods of teaching

and interactive board and calculator are mentioned as the main technology tool in the unit plans for mathematics in the partner high school. Moreover, the national mathematics curriculum for high school mentions the use of ICT tools for graphing in the 9th and for relating experimental probability and theoretical probability in the 11th grade. However in the implementation teaching involves mostly drill and practice rather than project based teaching approach in DA related topics. The amount of time spent on teaching mathematics is 216 hours at each grade level in high school. The amount of time for teaching data and probability at each grade level varies as seen in Table 3.

Table 3. Data and probability content in high school mathematics, including teaching methods, technology tools and amount of time for teaching

Key content	Learning objectives/Competencies	Subject (maths, science etc.)	Age/s	Teaching approach/methods	Technology tools used	Hours/Timing Aprox.
Measures of central tendency and spread	Students • Calculate and interpret measures of central tendency and spread	Mathematics	14-15 (9th grade)	Problem solving; question and answer; discussion	Interactive board/Calculator	8 (4%) May/June
Displaying data with graphs	Students • Represent data using histogram • Represent and interpret real life data using appropriate graph types *a) Comparing more than two data sets* *b) Using ICT tools for graphing* *c) Making graphs of data related to bread waste, water waste etc. (awareness of saving)*	Mathematics	14-15 (9th grade)	Problem solving; question and answer; discussion	Interactive board/Calculator	8 (3%) May/June

Arrangement and selection	Students • Calculate the number of events occurring using additional and multiplication rules • Calculate permutations • Solve problems related to permutations • Calculate combinations • Explain Pascal triangle Do binomial expansion	Mathematics	15-16 (10th grade)	Problem solving; question and answer; discussion	Interactive board/Calculator	26 (12%) Sept/Oct/Nov
Probability of simple events	Students • Explain sample space, experiment, outcome, complementary event, certain event, impossible event, mutually exclusive event and non-mutually exclusive event Perform applications related to probability concept (*real life problems*)	Mathematics	15-16 (10th grade)	Problem solving; question and answer; discussion	Interactive board/Calculator	12 (6%) Oct/Nov
Conditional probability	Students • Solve problems using conditional probability (*real life problems*) • Calculate probability of independent and dependent events (*real life problems*) Calculate probability of compound event (*real life problems*)	Mathematics	16-17 (11th grade)	Problem solving; question and answer; discussion	Interactive board/Calculator	14 (7%) May/June

Experimental and theoretical probability	Students Relate experimental probability and theoretical probability (*use of ICT*)	Mathematics	16-17 (11th grade)	Problem solving; question and answer; discussion	Interactive board/Calculator	4 (2%) June
Data analysis	Students • Solve statistical problems related to real life situations *a) Data collection, organization, representation and interpretation* *b) Use of different graph types* *c) Problems relevant to environmental awareness, reading habits etc.*	Basic level mathematics	17-18 (12th grade)	Problem solving; question and answer; discussion	Interactive board/Calculator	10 (13%) Sept/Oct

Geography is another subject area that requires data analytics skills in the high school national curriculum. Similar to the Mathematics Curriculum, the Geography Curriculum (MEB, 2018e) has been recently revised in light of the 21st century learning skills. As a result, in geography students are expected to develop evidence-based decision-making skills in climate related, historical, social, economic and political contexts as well as to make and interpret table and graphs based on data. Related learning objectives are shown in Table 4 and indicate the use of data to make inferences in various contexts. In the partner high school, the data provided in textbooks are usually used.

Table 4. Data related content in high school geography

Key content	Learning objectives/Competencies	Subject (maths, science etc.)	Age/s	Teaching approach/methods	Technology tools used	Hours/Timing Aprox.

Natural systems	Students • Explain formation and dispersion of climate elements *(They make tables and graphs using data about climate elements in their region and relate them with real life)*	Geography	14-15 (9th grade)			3 (7%) Nov/Dec
Natural systems	Students • Make inferences about the properties and dispersion of different climate types on earth *(Climate graphics based on climatologic data from real stations are included*)	Geography	14-15 (9th grade)			4 (8%) Nov/Dec
Human systems	Students • Make inferences about population characteristics and importance of population using statistical data	Geography	15-16 (10th grade)			2 (2,5%) Dec/Jan/Feb
Human systems	Students • Make inferences about historical change of world populati on using statistical data	Geography	15-16 (10th grade)			2 (2,5%) Dec/Jan/Feb

Human systems	Students • Associate the factors affecting population distribution and distribution of world population *(Only "mean population density" is included)*	Geography	15-16 (10th grade)			2 (2,5%) Dec/Jan/Feb
Human systems	Students • Analyze structural characteristics of Turkey's population using up to date data	Geography	15-16 (10th grade)			2 (2,5%) Feb/March
Human systems	Students • Make inferences based on the association between data about proportional distribution of types of economic activities and countries' level of development	Geography	15-16 (10th grade)			2 (2,5%) May/June
Human systems	Students • Analyze the relationship between natural resources in Turkey and economy (*using statistical data and representations*)	Geography	16-17 (11th grade)			4 (4%) Feb/March

Human systems	Students • Explain the process of the development of transportation in Turkey *(Emphasis is made on the importance of transportation system for our country using statistical data and graphics*)	Geography	17-18 (12th grade)			4 (3%) Feb/March

1.3. CONCLUSIONS OF THE CURRICULUM OVERVIEW

Next, the main conclusions are drawn from the curriculum overview in relation to the following aspects: a) DA related content in the middle and high school curriculum; b) the time allocation to teach DA related content; c) the teaching methods; d) the use of technology; and e) cross-curricular links with science and social studies.

a) DA related content in the middle and high school curriculum

The Turkish National Curriculum has a different structure in middle school and high school education. The middle school mathematics curriculum is comprised of five learning domains: 1) “Numbers and Operations”; 2) “Algebra”; 3) “Geometry and Measurement”; 4) “Data Handling”; 5) “Probability”. However, the high school mathematics curriculum is made up of three learning domains: 1) “Numbers and Algebra”; 2) “Geometry”; 3) “Data, Counting and Probability”. In both curricula data and probability are one of the learning domains.

The middle school curriculum focuses on the statistical investigation process, including formulating research question, collecting data, representing data and analysing and interpreting data in a progressive way throughout the grade levels. Probability concept is also introduced the first time in the last year of middle school. On the other hand, the high school curriculum has more emphasis on probability than data. Data topics include only representing data and analysing and interpreting data in the first year of high school. Even though it is important to develop the connection between statistical and probabilistic ideas starting from early grades (Konold & Kazak, 2008), there is a superficial isolation in teaching of data and probability topics in the middle school and high school curriculum in Turkey.

b) Time allocated in teaching DA related content within mathematics curriculum

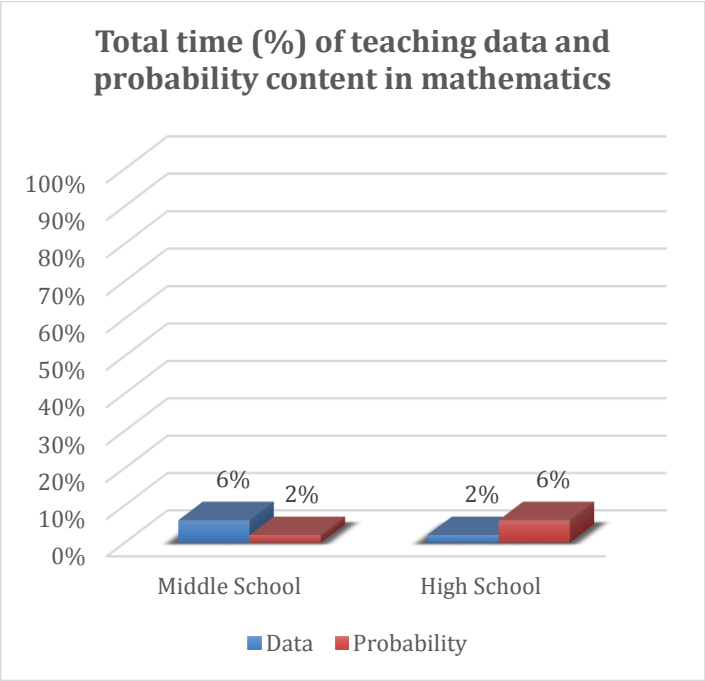

Figure 1: Total time (%) of teaching data and probability content in mathematics

As seen in Figure 1, the total time allocated to teach data and probability content overall is about the same (8%) in both middle school and high school mathematics curricula. However, there is a noticeable difference in allocated time for teaching data topics in middle school and high school. There is more emphasis on data topics in middle school than in high school while probability is emphasized more in high school. This seems to be consistent with current trend of deemphasizing or eliminating the study of probability in the early years of schooling (Langrall, 2018). Another important issue is that dedicating only 8% of the time for teaching mathematics, including all five learning domains in middle school and all three learning domains in high school, for DA related topics shows how little importance is given in promoting students' statistical literacy in school mathematics curriculum. SPIDAS project will help to address this issue by engaging students in solving real life problems with an interdisciplinary approach with connections to science and social studies.

c) Teaching methods

In teaching DA related topics in middle school and high school education, the most used methods are "problem solving" in the sense of drill and practice, "question and answer" and "discussion" as reported by the partner schools in this project. On the other hand, current theories of learning (constructivism and socio cultural theory) suggest designing learning environments that enable learners to construct knowledge. This imply to adapting a student-centred approach and providing learners "many opportunities to think, reason, and reflect on their learning, as well as discussing and reflecting with their peers" (Garfield & Ben-Zvi, 2008, p. 47). So it is important to engage students in learning activities, discussions and collaborative projects with the support of technology. SPIDAS project will promote such teaching approach.

d) Use of Technology

Although each classroom in partner schools have interactive board to support teaching and learning, its use in teaching DA related topics seems to be limited to showing content related video and answering multiple choice tests. While the national mathematics curriculum for both middle school and high school levels recommends the use of ICT tools for representing data, there is no use of digital data visualisation tools in teaching. This seems to be consistent with earlier research findings indicating that although the use of information and computing tools are recommended in school mathematics curricula in many countries, it is not central to mathematics instruction in schools for various reasons, such as lack of resources for teachers (Meletiou-Mavrotheris, Paparistodemou, & Stylianou, 2009). However, the effective learning environment requires using technological tools for building deeper understanding of statistical concepts and developing statistical reasoning in classroom (Garfield & Ben-Zvi, 2008).

e) Cross-curricular links with science and social studies

As seen in our curriculum overview mentioned earlier, mathematics is not the only subject where students engage in DA related content. While students learn the statistical concepts, tools and ideas (i.e., measures of centre and spread, graphs, data collection and so on) within mathematics curriculum, the other subject areas in the curriculum, such as science and social sciences at the middle

school level and geography at the high school level, provide opportunities for developing data/evidence-based decision-making skills using tables and graphs in various contexts. Since “data are not just numbers, they are numbers with a context” (Cobb & Moore, 1997, p. 801), the context of data and students’ understanding of that context is of great importance when students engage in DA. Therefore, cross-curricular links with science and social sciences in the curriculum can help students develop necessary DA skills, such as statistical literacy.

2. EXISTING RESEARCH ABOUT DATA ANALYTICS TEACHING AND LEARNING IN TURKEY

The aim of the literature review was to identify relevant and effective practices on teaching and learning of DA related concepts, skills and ideas in the national context. Due to the absence of professional journals intended as a resource for teachers in Turkey, the review was limited to peer-reviewed research journals and master’s/PhD theses.

First, the literature review process was explained. Then the main findings in relation to DA teaching and learning were presented.

2.1. LITERATURE REVIEW PROCESS

The literature review in the context of Turkey focused on the studies relevant to DA teaching and learning at the middle school and high school education. The sources consulted included national databases, such as Council of Higher Education Thesis Center and ULAKBIM (Turkish Academic Network and Information Center), google scholar, and websites of national journals related to mathematics education. The following keywords were searched: statistics, statistical literacy, data handling, data analysis, real world problems, statistical problems, technology supported statistics education, middle school, and high school.

As a result of this literature review process, nine studies related with the teaching and learning of data topics at primary, middle and high schools were found relevant for this project. Five of these were completed theses (four master’s theses and one doctoral dissertation) between 2006 and 2017. The other four studies were from peer-reviewed journals published in 2014 and 2015.

2.2. OVERVIEW OF RESEARCH

In Turkey, there has been an increasing interest in research on teaching and learning of data analysis at school level in the last decade due to a greater emphasis on data topics in the school curriculum starting from primary school since 2005. The review of nine selected studies (see the summary table in section 2.3) shows that research interests primarily focus on the use of different teaching approaches, technology and learning tasks to foster students’ statistical understanding, and variables affecting students’ performance in statistics, such as attitudes towards statistics.

2.2.1. Student-centred teaching approaches

Two of the studies focus on the use of project-based learning approach (Koparan, 2012) and realistic mathematics education approach (Cihan, 2017).The common feature of these different teaching approaches was that students in small groups were engaged in specific tasks with the guidance of the teacher.

The comparative studies using quasi experimental research method showed the effectiveness of project-based learning approach on 8th grade students' statistical literacy levels (Koparan, 2012) and of realistic mathematics education (RME) approach on 8th grade students' achievement related to statistics and probability (Cihan, 2017). These findings suggest that allowing students to work on a project related to a real life context for a period of time using various resources, such as encyclopaedia, internet, surveys, interviews, newspapers, journals, institutions for data collection and tools for graphing and presenting results can foster students' statistical literacy. Moreover, as seen in the RME approach, the use of concrete problems that are real for the students, allowing students to develop their own methods of problem solving and discuss different approaches, the class discussions and teacher guidance are important aspects student-centred teaching approaches and learning tasks used in teaching statistics.

2.2.2. Use of technology

The use of educational software designed for young students to explore data, such as TinkerPlots (Konold and Miller, 2011), also can support students' learning of key statistical ideas starting from primary grades. As seen in the findings of Koparan and Kaleli (2014), the combination of using real data about students themselves and the dynamic data exploration software TinkerPlots can promote young students' informal inferential reasoning skills. Some of affordances of TinkerPlots are allowing students to use various data representations to make inferences based on data and to spend more time in making conjectures and develop arguments rather than focusing on calculations. However, the study by Avcı (2017) points out that teachers have difficulties in using technology by themselves. They also tend to use technology as a means of supplementary tool for teaching rather than as a means of supporting students' learning during the lessons.

2.2.3. Statistical investigation process and context knowledge

Solving a statistical problem involves an investigation process that comprises of formulating a problem, collecting data, analysing data and interpreting data. Although these phases are addressed in the middle school mathematics curriculum in Turkey, they are taught separately at different grade levels. Hence, Güven, Öztürk and Özmen (2015) developed tasks in which students could engage in this statistical investigation process through all its phases. The tasks involved collecting real life data in given four different contexts: Transportation preferences of tourists coming to Turkey, export in Turkey, newly born babies and calories in our lives. Students working in groups of 4-5 completed these tasks by engaging in the statistical investigation process: 1) Formulating a problem, 2) making a hypothesis, 3) data collection, 4) data analysis, 5) interpreting data. The

findings showed that students initially tended to formulate questions that did not require collecting data. During the data collection stage, they began to focus on statistical problems as they collected quantitative data related to context. When stating hypotheses, the context was important. If students were familiar with the context in their daily lives, they tended to be better in making conjectures. They had difficulties in gathering data. One group just guessed the data. The groups with familiar contexts did better in finding out the variables they needed to consider in data collection. For data analyses, students tended to make simple tables with one variable for quantitative data. When making graphs, they generally showed data in ordered pairs between the variable they investigated and the corresponding numeric data. In the data interpretation stage, only two of the groups investigating export and food calorie contexts were able to interpret data using tables and graphs. Others just presented general information about the context. Students had difficulties in making inferences based on data.

Combining statistical and contextual knowledge is an important aspect of statistical thinking (Wild and Pfannkuch, 1999). Koparan, Güven and Karataş (2014) investigated how 11th grade students use the context knowledge in analysing and interpreting real life data. The findings showed that students have difficulties in combining their mathematical/statistical knowledge and context knowledge when making decisions based on data. Students mostly relied either on their context knowledge or only mathematical/statistical knowledge without context. Hence, it is suggested that real life problems are discussed more often in the classroom in order to promote students'' statistical and contextual knowledge together.

2.2.4. Students' attitudes towards statistics

Students who have developed strong feelings or ideas involving statistics may have or have not difficulties in learning statistics depending on the attitudes they carry with them (Gal, Ginsburg and Schau, 1997). Hence, it is important to assess student attitudes regarding statistics.

Gürsoy, Güler and Çelik (2014) investigated the relationship between the attitudes towards statistics and other variables, such as gender, grade level, and mathematics achievement with 372 7th and 8th grade students (207 female and 165 male). The study showed that female students had more positive attitude towards statistics than male students. Moreover, 7th graders had more positive attitude towards statistics than the 8th graders. It is argued that this could be related to anxiety due to the test the 8th graders have to take before high school. The study also revealed that the students with high mathematics achievement had more positive attitude towards statistics than the students with low mathematics achievement. In another study 1074 8th grade students, Yolcu (2012) found a positive and significant relationship between students' attitudes towards statistics and their statistical literacy scores. This result supports that dispositions, such as attitudes, developed by students play an important role in influencing their learning process with regard to statistics (Gal et al., 1997).

Yılmaz (2006) examined the effects of teaching supported by the use of real data and calculator on 7th grade students' attitudes towards statistics. Activities with

real data included the sports news taken from the newspapers and magazines and the calculators had statistical functions, such as data collection and data summarization. The results showed that the students who engaged in those activities had positive attitude on 'confidence in statistical learning' subscale. Additionally, most of the students mentioned that they enjoyed the activities and the calculators made the study easy.

2.3. SUMMARY OF THE PAPERS REVIEWED

Yılmaz, S. (2006). *The effects of real data based and calculator supported statistics activities on 7th grade students' statistics performance and attitude toward statistics*. Unpublished Master's Thesis. Middle East Technical University, Ankara.	
Education level	7th grade
Participants	84 7th grade students
Research method (if applicable)	Quasi experimental research, including 2 experimental groups and 1 control group. Experimental group 1 completed real data based statistical tasks; experimental group 2 completed real data based statistical tasks using calculator; control group did traditional teaching.
Activities/Projects (about daily life?)	By using the real data sets in the sports section of the newspapers, students did tasks related to calculation of mean, median, mode; pie chart, pictogram, bar graph, and line graph.
Properties of data used (Data type, data set size, real life data etc)	Quantitative data (whole numbers) 5 data in each data set Real data
Pedagogy (theoretical perspective)	-
Technology	Calculator
How students analyse data	Calculating and interpreting mode, median and mean of real data sets Reading graphs Summarising data Statistical terminology
Data collection	Statistical performance test (pre and post tests) Statistical attitude test

instruments (attitude test, achievement test etc)	
Results	No significant difference in statistical performance and in statistical attitude between groups Students who did activities based on real data had positive attitude on confidence in statistical learning; stated that they enjoyed the lessons. Students who used calculators stated that the calculators made their work easier.

Yolcu, A. (2012). *An Investigation of Eighth Grade Students' Statistical Literacy, Attitudes Towards Statistics And Their Relationship*. Unpublished Master's Thesis. Middle East Technical University, Ankara.	
Education level	8th grade
Participants	1074 8th grade students (8 different schools)
Research method (if applicable)	Cross-sectional survey research design and correlational research design
Activities/Projects (about daily life?)	-
Properties of data used (Data type, data set size, real life data etc)	The quantitative data given in the test items are whole numbers in general with some exceptions of decimals, such as 1,5 and 12,5 6 data in data sets Data are related to real life contexts but not real data
Pedagogy (theoretical perspective)	-
Technology	-
How students analyse data	Statistical literacy test included questions related to sample, average, graphs, probability, inference and variation. For example,

	Stage 1:“Last year, an average of 20 people had died due to traffic accident.” What do you understand the word “average” in this sentence? Stage 2: “A researcher who lives in a town consisting of 50 families has found the mean of children per family as 2.2. Which one of the followings is absolutely true? a. Half of the families in this town has two children b. The number of families with 3 children more than families with 2 children. c. There are 110 children in this town. d. The mean of children per adult is 2.2. Stage 3: The number of problems solved in a math class is counted and represented in the following table
Data collection instruments (attitude test, achievement test etc)	* Attitudes toward statistics instrument (adapted from Bulut, S. (1994). The effects of different teaching methods and gender on probability achievement and attitudes toward probability. Unpublished Doctoral Dissertation, Middle East Technical University, Ankara.) * Statistical literacy test (Adapted from Watson, J. (1997). Assessing Statistical Thinking Using Media. In I. Gal, & J. Garfield (Eds.), The Assessment Challenge in Statistics Education (s. 107-122). Amsterdam: IOS Press)
Results	* Students had positive attitudes toward statistics * There is a positive and significant relationship between statistical literacy and attitudes towards statistics * There is significant difference between 2nd and 3rd stages of statistical literacy test. In other words, student performance was the highest in "stage 2-interpreting statistical knowledge in context" and the lowest in "stage 3-evaluating the inappropriate statistical claims".

Avcı, E. (2017). *Ortaokul matematik öğretmenlerinin* Vustat *ve* TinkerPlots *yazilimlarinin veri işleme öğrenme alaninda kullanilabilirliği ile ilgili görüşleri* [Middle school teachers' opinions about using Vustat and TinkerPlots in the learning area of data processing in middle school mathematics]. Unpublished Master’s Thesis, Mersin Üniversitesi, Mersin.	
Education level	5th-8th grades

Participants	14 middle school mathematics teachers (from different schools at different SES, 25-40 year olds, years of teaching experience mostly 6-15 years)
Research method (if applicable)	Phenomenology research design
Activities/Projects (about daily life?)	Activities were developed based on the learning outcomes in the curriculum with the use of two data analysis technology tools (VuSTAT and TinkerPlots, 12 and 9 activities respectively). Student activity sheets included detailed guidance for the students at each step to make calculations and graphs without any choice given to students. Procedure: Over 5 days teachers engaged in these activities using the software and evaluated them at the end.
Properties of data used (Data type, data set size, real life data etc)	Data values between 0-100 (natural numbers) Non-real data Data sets of 15-16 data
Pedagogy (theoretical perspective)	-
Technology	VuSTAT (educational app for statistics-data analysis tools and simulations- developed by Piet van Blokland and Carel van de Giessen, translated to Turkish by Hatice Akkoç and Sibel Yeşildere-İmre) TinkerPlots (dynamic data analysis software)
How students analyse data	-
Data collection instruments (attitude test, achievement test etc)	* Pre interviews * Activity sheets * Evaluation forms for technology tools * Focus group interviews for opinions about the use of technology tools
Results	* Teachers tend to use technology as a means of supplementary tool for teaching, rather than as a means of supporting students' learning outcomes during the lessons. * Teachers have difficulties in using technology tools

	* Both technology tools are appropriate for statistics teaching but the language of software is important (positive for VuSTAT because it is in Turkish)

Koparan, T. & Kaleli Yılmaz, G. (2014). *Dinamik istatistik yazılımı ile veri analizinde ilkokul öğrencilerinin informal çıkarımlarının incelenmesi* [Examination of elementary school students' informal inference in data analysis with dynamic statistics software]. *Bayburt Üniversitesi Eğitim Fakültesi Dergisi, 9*(2), 95-113.	
Education level	3rd grade
Participants	106 3rd grade students (3 different classrooms) (interviews with 12 students)
Research method (if applicable)	Case study
Activities/Projects (about daily life?)	Students develop a survey to collect data about themselves (what time they go to sleep-before or after 10pm-, how many time they brush their teeth in a day, whether they play with scissors, favourite food etc) Selected 12 students in small groups participated in the data analyses activities with TinkerPlots during the interviews. Data based inferences and generalizations beyond data were encouraged.
Properties of data used (Data type, data set size, real life data etc)	Categorical data Real data about students themselves
Pedagogy (theoretical perspective)	
Technology	TinkerPlots for displaying data and making inferences
How students ana lyse data	Students make graphs (split bar charts, dot plots, pie charts to compare groups) to answer their research questions. Interviewer encourages students to make generalizations beyond data
Data collection instruments (attitude	-

test, achievement test etc)	
Results	* Students demonstrated more interest and effort for understanding and interpreting data because the data were about themselves. * Some students used personal experiences to support the data ("most of them live close to school" for why most students walk to school) in their conclusions while some used data to support their personal experiences. * With the support of the interviewer students used different data representations in TP to make inferences beyond data. * Student used probabilistic language (such as "maybe, more likely, possible") to generalize results for larger population.

Güven, B., Öztürk, T. & Özmen, Z. M. (2015). *Ortaokul sekizinci sınıf öğrencilerinin istatistiksel süreçteki deneyimlerinin incelenmesi* [Examining the statistical process experiences of 8th grade students]. *Eğitim ve Bilim, 177*(40), 343-363.	
Education level	8th grade
Participants	22 8th grade students
Research method (if applicable)	-
Activities/Projects (about daily life?)	Activities were implemented in the class in 4 contexts: Transportation preferences of tourists coming to Turkey, Export in Turkey, Newly born babies and Calories in our lives. Each activity involves statistical investigation process: 1) Formulating a problem, 2) making a hypothesis, 3) data collection, 4) data analysis, 5) interpreting data. Students worked in groups of 4-5. Each group worked on one of the given contexts above. First students completed the first two stages of their statistical investigation. During the following two weeks they were asked to complete their data collection, analysis and interpretation and write a report. Then they presented their work in the class.
Properties of data used (Data type,	Real life data

data set size, real life data etc)	
Pedagogy (theoretical perspective)	-
Technology	-
How students analyse data	Students created tables and graphs (value bars, line graph)
Data collection instruments (attitude test, achievement test etc)	Student responses to the guiding questions on the activity sheet. Student reflection papers regarding their statistical investigation process Video recordings of class discussions
Results	* Students initially tended to formulate questions that did not require collecting data. During the data collection stage, they began to focus on statistical problems as they collected quantitative data related to context. * When stating hypotheses, the context was important. If students were familiar with the context in their daily lives, they tended to be better in making conjectures. * They had difficulties in gathering data. One group just guessed the data. The groups with familiar contexts did better in finding out the variables they needed to consider in data collection. * For data analyses, students tended to make simple tables with one variable for quantitative data. When making graphs, they generally showed data in ordered pairs between the variable they investigated and the corresponding numeric data (see example below). Other graphs included value bars (see below) and line graph. They focused on one variable. * In the data interpretation stage, only two of the groups investigating export and food calorie contexts were able to interpret data using tables and graphs. Others just presented general information about the context. Students had difficulties in making inferences based on data.

Gürsoy, K., Güler, M. ve Çelik, R. (2014). *Ortaokul 7 ve 8. sınıf öğrencilerinin istatistiğe karşı tutumlarının çeşitli değişkenler açısından incelenmesi* [The investigation of attitudes towards statistics of the 7th and 8th grade middle school students according to some variables]. *Turkish Journal of Computer and Mathematics Education, 5*(1), 60-72.	
Education level	7th and 8th grades
Participants	372 students from 4 different schools (7th grade: 155, 8th grade: 217; 207 female and 165 male)
Research method (if applicable)	Descriptive/correlational Independent t-test (gender and grade levels) and ANOVA (math achievement) Investigation of the relationship between 7th and 8th graders attitudes toward statistics and gender, grade level and math achievement
Activities/Projects (about daily life?)	-
Properties of data used (Data type, data set size, real life data etc)	-
Pedagogy (theoretical perspective)	-
Technology	-
How students analyse data	-
Data collection instruments (attitude test, achievement test etc)	Statistics attitude test (20 items, 5 Likert type scale) (Yılmaz, 2006) Ref: The Effects Of Real Data Based And Calculator Supported Statistics Activities On 7th Grade Students' Statistics Performance And Attitude Towards Statistics. Yılmaz, Sevgül. 2006. MS thesis. Advisor: Erdinç Çakıroğlu Personal info sheet (gender, grade level and achievement)
Results	* Female students had more positive attitude towards statistics than male students.

	* 7th graders had more positive attitude towards statistics than 8th graders (this could be related to test anxiety about the high school entrance exam at grade 8) * Higher math achieving students had more positive attitudes towards statistics than the low/medium achieving students

Cihan, E. (2017). *Gerçekçi Matematik Eğitiminin Olasılık ve İstatistik Öğrenme Alanına İlişkin Akademik Başarı, Motivasyon ve Kalıcılık Üzerindeki Etkisi* [The effect of realistic mathematics education on achievement, motivation and retention about probability and statistical learning field]. Unpublished Masters Thesis. Çukurova Üniversitesi, Adana.	
Education level	8th grade
Participants	90 8th grade students
Research method (if applicable)	Pretest-Posttest controlled experimental design
Activities/Projects (about daily life?)	-
Properties of data used (Data type, data set size, real life data etc)	Real life problems and data
Pedagogy (theoretical perspective)	Experimental group: Realistic Mathematics Education (RME) approach 2 control groups: Traditional teaching Duration: 7 weeks, 40 hrs RME approach procedure: Intro: Presenting the concrete problem, making groups Activity: Discovery (Students develop their own methods for problem solving; they discuss different methods), reflection/explanation (group representative presents their problem solution and the result; class discussion) Evaluation: Formulation (Teacher guides students to help them find formulas and mathematical statements and explains), a new problem similar to the previous one is given and randomly picked student solves the problem at the board.

Technology	-
How students analyse data	-
Data collection instruments (attitude test, achievement test etc)	Maths achievement test (TIMMS 2007 and 2011, PISA 2003 and 2012 questions related to probability) Motivation towards maths scale (Shia (1998))
Results	* RME approach is found to be more effective in terms of maths achievement and retention. * Motivation towards maths and scores on intrinsic and extrinsic motivation are statistically different in favour of the experimental group

Koparan,T., Güven, B., Karataş,İ. (2014). Lise öğrencilerinin veri analizinde bağlam bilgileri ile matematiksel /istatistiksel bilgilerini kullanim şekilleri [Use of high school students' context and mathematical/statistical knowledge forms in analyzing data]. *Bilgisayar ve Eğitim Araştırmaları Dergisi, 2*(4), 1-22.	
Education level	11th grade
Participants	120 11th grade students from two different high schools
Research method (if applicable)	Descriptive research design Aim: to investigate how students use the context knowledge in data analysis and interpretation and whether context knowledge supports students' statistical perceptions.
Activities/Projects (about daily life?)	-
Properties of data used (Data type, data set size, real life data etc)	3 questions based on real data 1) Is Bruce Willis more successful in action/suspense films or in comedy films? 2) Olympics data on discus throw (medals won by man and women) and comparing gender performance 3) Comparing data from 3 seasons for Ronaldo and Messi's performance
Pedagogy (theoretical perspective)	Theoretical model for the relationship between context and mathematical knowledge construction:

	Dapueto, C. & Parenti, L. (1999) Contributions and obstacles of contexts in the development of mathematical knowledge. Educational Studies in Mathematics, 39, 1-21
Technology	Calculator
How students analyse data	-
Data collection instruments (attitude test, achievement test etc)	-
Results	* 38% of student responses include only context knowledge. * 30% of the responses focus only on mathematical and statistical properties without context. * 11% of the responses include both mathematical and statistical knowledge and context knowledge. * When making a decision, they tend to ignore mathematical and statistical knowledge. * Students have difficulty in combining their maths-stats knowledge and context knowledge.

Koparan, T. (2012). *Proje tabanlı öğrenmenin öğrencilerin merkezi eğilim ve yayılım ölçülerine yönelik istatistiksel okuryazarlık seviyelerine etkisi* [The effect of project based learning approach on the statistical literacy levels and attitude towards statistics of student]. Unpublished Dissertation, KTÜ, Trabzon.	
Education level	8th grade
Participants	70 8th grade students (experimental group: 35, control group:35)
Research method (if applicable)	Quasi experimental research design Aim: to investigate the effect of project-based learning approach on students' statistical literacy levels and their attitudes towards statistics.
Activities/Projects (about daily life?)	In project-based learning group: The following resources and tools are expected to be used in student projects: textbooks, encyclopaedia, tests, school library, internet, cell phone, surveys, interviews, tv, newspapers, journals, institutions for data

	collection, computer, camera, programs for writing text, graphing and presenting. At the end of 4 weeks students in groups of 2-3 completed their project reports and presented in the class. 12 project topics: students' blood type, Turkish Super League teams' scores in the first half term, people's average time of running 100 m, students'' height and weight, 8the grade students maths achievement, Trabzon airport flight and passenger statistics, waste in our environment and threat and precautions, students' household numbers and parent education level, musician selection for the end of year festival and its budget, daily activities of students, the usage time of tv, internet and cell phone, students' preferences for occupation. In the control group: Traditional teaching (lecture, question and answer, problem solving etc)
Properties of data used (Data type, data set size, real life data etc)	Real data collected by students for the project
Pedagogy (theoretical perspective)	Project-based learning
Technology	-
How students analyse data	-
Data collection instruments (attitude test, achievement test etc)	Statistical literacy test: 69 items on sample, data representation, central tendency and variability measures, probability, inference, variation. Statistical attitude test
Results	* There is a significant difference between groups on both statistical literacy levels and statistical attitudes in favour of experimental group * Before the treatment statistical literacy levels of the students in both groups were mostly at level 3. After the treatment, 1/3 of the students in the experimental group moved to level 4 while 1/10 of the students in the control group moved to level 4.

	* After the project-based learning, students began to make connection to the context but continued to think uncritically. * Before the project-based learning, students tended to give personal responses about biased and wrong sampling, but after the treatment they tended to prefer representative and random sampling methods and to think critically in the familiar contexts. * Students, who initially could not describe measures of central tendency, mixed different measures and misused the algorithm of mean, were able to explain the concepts of mean, median and mod after the project-based learning. * Students were better in reading and interpreting bar graphs and pictograms than line graphs and pie charts. They had also difficulty in choosing the most appropriate graph type for data representation.

3. STUDENTS' INTEREST

In order to investigate students' knowledge and interests about weather, climate and climate change, focus group study was conducted using the same procedures as described in Section 4 of the Local Report Spain.

Twenty six 12-13-year-old and thirty one 16-17-year-old students participated in the focus group study from two partnering schools in Turkey. Students' responses are summarised by the questions asked in the following table.

Table 5. Middle school and high school students' responses with regard to their knowledge and interests about weather, climate and climate change

1) What / who is responsible of extreme climate episodes? (12-13 year olds)	1) What / who is responsible of extreme climate episodes? (16-17 year olds)
• Humans • Global warming • Waste (factory, domestic etc) • Damaging natural life • Greenhouse effect • Extreme air pollution • Cutting of trees • Ill-planned urban transformation	• Humans • Global warming • Waste (factory, domestic etc) • Damaging forests • Greenhouse effect • Pollution (environment, water, air etc.) • Ill-planned urban transformation • Emission of harmful gases • Misuse of water sources/land • Thinning of ozone layer • Building artificial ponds and reservoirs • Fossil fuel

2) What actions/ who / how could mitigate these extreme climate episodes?(12-13 year olds) • Humans • Raising public awareness • Publishing scientific books about extreme climate • Using environment-friendly products • Using filters in factory chimneys • Using renewable energy sources • No extracting oil/gas from the Arctic • Using electric cars, public transportation • Forestation • No harm to nature • Recycling	2) What actions/ who / how could mitigate these extreme climate episodes?(16-17 year olds) • Humans • Raising public awareness • No harm to animals and cultivated areas during urbanization • Reducing the use of cosmetic products harmful for ozone layer • Taking measures against chemicals harmful for nature, such as industrial waste • Better planning for urbanization • Recycling • Joining to non-profit organizations • Taking measures against air pollution • Using public transportation • Forestation
3) How do weather and climate change affect our life?(12-13 year olds) • Negative effect on biodiversity • Migration of animals and people increases • The balance of producer, consumer and decomposer is broken • Living spaces of all creatures are in danger • We live summer in spring due to global warming • It makes our living conditions difficult • Food competition begins • Diseases and viruses increase • It affects us both physically and psychologically • Global warming increases due to air pollution • Crops are damaged due to heavy rains	3) How do weather and climate change affect our life?(16-17 year olds) • It damages human health and animals • Glaciers are melting • It affects us psychologically • It damages soil and our products;increases dependence on foreign sources • Increase in diseases • Unemployment increases because of no farming, no livestock • Decline in tourism and national income • It hinders students' education • Difficulty in transportation • It changes nutrition habits / GMO • It affects economy • Shifting seasons • Decline in growing crops • Drought • Animals have no food, water, home

4) Which of these effects would you like to study and know more? Why? (12-13 year olds) • Fog and acid rains / Because we wonder about how acid rain occurs • Flood / Because it occurs a lot and harms our living spaces • Air pollution/ Because we need clean air • Destruction of natural life / Because climate change affect both animals and humans • Rain/ Because it happens a lot and affects our mood • Global warming / Because we want to know if there is global warming or global cooling	4) Which of these effects would you like to study and know more? Why? (16-17 year olds) • Food production before its growing season / For healthy nutrition • Increase in diseases related to climate change / For taking precautions about our health • Global warming / Because we are uncertain about our future • Effects on people's mood/ Because psychology is the essential nature of human • Air pollution / Because we cannot stop air pollution once it is done; we need to be sensitive to nature and environment • Effects on farming and livestocking / Because cattle cannot graze and people cannot produce crops due to drought • Change in nutrition habits / Because it affect out health • Diseases related to air pollution / To prevent its transition to future generations and to decrease the death rate • The reasons for extinction of endangered species due to climate change / Because the absence of animals harms nature and to protect them and nature

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MEB (2018c). *Fen Bilimleri Dersi Öğretim Programı (İlkokul ve Ortaokul 3, 4, 5, 6, 7 ve 8. Sınıflar)* [Science curriculum (Primary and middle school grades 3-8)]. Ankara: TTKB.

MEB (2018d). *Sosyal Bilgiler Dersi Öğretim Programı (İlkokul ve Ortaokul 4, 5, 6 ve 7. Sınıflar)* [Social sciences curriculum (Primary and middle school grades 4-7)]. Ankara: TTKB.

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