Statistical Learning Trajectory Using The Time Context Of Social Media Usage

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Abstract

This study aims to design a statistical learning trajectory using social media usage time data as a starting point or learning context. The method used in this study is design research with the stages of preliminary design, design experiment and retrospective analysis. The subjects in this study were several samples of grade XI high school students. The results of this study are a hypothetical learning trajectory design in statistics learning using social media usage time data with a learning trajectory that is the time spent by students in using social media (Tiktok, Instagram and WhatsApp) to find the measure of central tendency, data location and distribution of single data and group data with agreed provisions. Students record the starting point and end point in the activity of recording students' social media usage time and finally students find a statistical formula.

Keywords: Learning path, statistics, realistic mathematical approach

Introduction

Statistics is a branch of mathematics that is closely related to everyday life. In an increasingly connected and data-driven world, the ability to understand, analyze, and interpret data is a crucial skill for the 21st century (OECD, 2018). Statistics is a crucial part of the mathematics curriculum for secondary education (Midgett & Eddins, 2001). Statistics plays a crucial role in developing students' skills in collecting, organizing, analyzing, and interpreting data logically and meaningfully. Mastery of statistical concepts is essential in everyday life, including making data-driven decisions, interpreting graphs or tables of information, and understanding statistically-based news. However, teaching statistics still faces various challenges, particularly related to students' conceptual understanding (Garfield & Ben-zvi, n.d.).

One of the main problems in statistics learning is that the material tends to be abstract, procedural, and not directly related to students' real-life situations (Nursyahidah et al., 2024). This causes many students to struggle to grasp concepts such as measures of central tendency, data dispersion, data location, and the presentation of data in graphs or tables. Students are often taught only how to use formulas such as mean, median, and mode mechanically, without understanding the context or meaning of the data they are processing. This condition is in line with findings that students often experience difficulties in understanding

mathematical concepts because learning is still oriented toward memorizing formulas and example-based problem solving, without connecting mathematics to real-life contexts (Rahmi et al., 2021). This results in students' understanding of statistics being shallow and limited to calculations. Statistics, in fact, is a critical and analytical thinking tool for making data-driven decisions. As a result, students' ability to apply statistical knowledge in everyday life contexts is low (Lestari and Surya, 2017).

In addition, students' mathematical abilities, including communication skills, are still relatively low. Mathematical communication is an important competency that enables students to express ideas, interpret data, and represent mathematical situations in various forms such as tables, graphs, and symbols (Carlsen et al., 2024). However, many students experience difficulties in communicating mathematical ideas due to inappropriate learning approaches and lack of meaningful learning experiences (Septriansyah et al., 2023). This is also supported by the fact that Indonesian students still show low performance in international assessments such as PISA, indicating weak mathematical literacy (Rusdi et al., 2020).

An alternative solution considered capable of addressing these issues is the Realistic Mathematics Education (RME) approach. The Realistic Mathematics Education (RME) approach offers a potential solution by framing mathematics as a human activity closely linked to students' real-world contexts. By using realistic situations as a starting point for learning, RME bridges abstract concepts with meaningful experiences relevant to the students. RME-based instruction fosters interactivity and active discussion, providing students with the space to explore, articulate their thought processes, and communicate mathematical ideas with greater confidence and meaning (Gravemeijer, 1994).

This approach, first introduced by Hans Freudenthal in the Netherlands, considers mathematics as a human activity that develops from concrete experiences to abstract concepts through a process of modeling and reflection (Gravemeijer, 1994). Research shows that RME not only improves students' conceptual understanding (Rahmi et al., 2021), but also has a significant positive effect on students' mathematical communication skills compared to conventional learning approaches (Septriansyah et al., 2023).

The realistic mathematics approach is an approach to learning mathematics that begins with a real problem, then is transformed into a formal expression through a structured mathematization process, all in a positive learning environment (Mawaddah and Anisah, 2015). In a realistic mathematics approach, students play an active role in their learning, with the

teacher acting as a guide and facilitator. Students are encouraged to articulate their thoughts, exchange ideas, and communicate openly with one another (Graciella and Suwangsih, 2016). With a realistic mathematics approach, students are faced with real-life problems that must be solved (Purba, 2017). This realistic mathematical approach allows students to explore and reconstruct mathematical concepts, resulting in a deeper understanding.

Through this realistic mathematics approach, learning is expected to serve as a bridge for mathematics learning, as it begins with the realities of students' daily lives. This approach is also effective in improving students' communication abilities, as students are trained to express ideas through symbols, diagrams, tables, and mathematical language during the learning process (Septriansyah et al., 2023).

One important aspect of this realistic mathematics education-based learning design is the Hypothesis Learning Trajectory (HLT) (Nursyahidah et al., 2024). The HLT is developed by integrating RME principles, ensuring that each learning activity is designed in a step by step manner starting from real world contexts, the use of models, and student to student discussion, and culminating in the formation of formal mathematical concepts. Consequently, an RME based HLT not only predicts the student learning process but also guides the mathematization process from real-world situations toward a meaningful understanding of concepts (Indrawati et al., 2025).

The HLT is a prediction or assumption of how students' learning will proceed when they are exposed to a series of learning activities designed based on a specific context. According to (Simon, 2020), a learning trajectory consists of three main components: learning objectives, designed learning activities, and hypotheses about students' thinking processes or understanding.

By formulating appropriate learning trajectory hypotheses, teachers can anticipate how students will think, what difficulties might arise, and how didactic interventions can be provided. Furthermore, contextual learning supported by realistic approaches has been shown to facilitate students' mathematical literacy and make learning more meaningful (Rusdi et al., 2020).

In the context of statistics learning, a realistic mathematical approach can be used by raising current issues relevant to students' lives, such as social media usage. Students can be asked to record and collect data on their social media usage for one week. This data can then be analyzed to determine average usage time, identify extremes (maximum and minimum), determine the median and mode, and present the data in tables or diagrams. This way,

learning not only becomes more meaningful and contextual but also enhances students' digital awareness.

The statistical concepts studied include determining the value of the measure of central tendency, the measure of location, and the measure of dispersion. Based on interviews with teachers, student grades tend to be low, students tend to memorize formulas, and there is no activity to discover the concepts in students' daily lives. This aligns with findings that low mathematical communication skills are caused by teacher-centered learning and lack of contextual problem-solving activities (Septriansyah et al., 2023). Furthermore, teachers never apply context-based learning in students' daily lives. This indicates that students do not possess or acquire meaningful statistical concepts. Teachers must provide a positive and engaging impression and be able to create a learning atmosphere that makes students feel happy and active in learning. One way to do this is by designing a learning trajectory that suits the students' conditions. This learning trajectory allows teachers to build students' thinking and process meaningful learning activities so that learning objectives can be achieved properly (Fakhmi, Sampoerna, and Meiliasari, 2021).

In this statistics material, the context used is the amount of time students spend using social media (Tiktok, Instagram, and WhatsApp) during a week in hours. However, this context will be modeled using tabular data presentation and dotplots. Bakker (Bakker, 2014) also uses dot plots in their learning activities by adding a sample (growing sample) that involves the concepts of sampling, data centering, and data distribution. Dot plots are even present in several mathematics textbooks. Based on this background, researchers are interested in discussing learning trajectories in statistics material using a realistic mathematics approach. By using the context of social media usage time and following a gradual statistical learning trajectory, students are expected to be able to build an understanding of data collection, presentation, and analysis in a meaningful and contextual manner. The purpose of this study is to develop a statistical learning trajectory using the context of social media usage time data.

Method

This study employs the design research method with a qualitative approach. This method was selected because it is highly suitable for iteratively designing, testing, and evaluating a learning trajectory (Hypothetical Learning Trajectory/HLT), as well as for understanding how students' thinking processes evolve during statistics instruction. Through

design research, the researcher can bridge learning theory with actual classroom practice to generate a Local Instruction Theory based on contextual activities (Gravemeijer, 1994).

Design research was chosen to develop a theory about the learning process, designed to develop new theories that can explain educational and learning phenomena. Design research will produce program designs, learning strategies, teaching materials, products, and systems that can be used to empirically solve problems in learning or education (Lidinillah, 2018). According to Gravemeijer and Van Eerde, design research is a research method carried out in collaboration between teachers and researchers with the aim of developing local instruction theory to improve the quality of learning (Adolph, 2016).

The subjects being class XI SMA. This study consisted of two cycles. The first cycle (small group) consisted of six students from class XI F2. The subject selection technique in this study used purposive sampling. According to Sugiyono, purposive sampling is a technique for sampling data sources based on certain considerations (Sugiyono, 2020). Meanwhile, the second cycle (field test) involved a full class of class XI F1 consisting of 20 people.

In design research, there are three stages (Prahmana, 2018), These stages are the preliminary design stage, the experimental design stage, and the retrospective analysis stage. This first stage, the preliminary design stage, involves the creation of a Hypothesis Learning Trajectory (HLT) and classroom learning observations. The HLT design in this study is based on the approach used by the researcher, namely a realistic mathematics approach, interviews with teachers, suggestions from the supervising lecturer, and literature studies related to statistics learning. The next stage, the experimental design stage, involves implementing learning in accordance with the learning design developed in the preliminary design stage. This trial was conducted to determine students' abilities in accordance with the instruments designed in the preliminary design stage. In the final stage, the researcher analyzed the results of students' work and produced a learning path that aligns with students' understanding (Asfyra, 2017). All data collected at the design experiment stage will be analyzed at the retrospective analysis stage. What has been produced will be compared with the HLT that has been created.

The data collection technique in this study was carried out in two stages: the preliminary design stage and the teaching experiment stage. In the preparatory stage, data collection included teacher interviews and classroom observations. The results obtained in this phase were Student Worksheets (SW), teaching modules, and Learning Trajectory

Hypotheses (HLT). Meanwhile, in the teaching experiment stage, the researcher piloted the designed learning activities through two stages: the first cycle (pilot experiment) and the second cycle (teaching experiment). In the teaching experiment phase, the designed HLT was piloted to obtain data from students' learning and thinking outcomes.

In this study, the data obtained was qualitative in nature so that data analysis was carried out before, during, and after in the field (Sugiyono, 2019). The data analysis component used is the Flow Model. Miles and Huberman define analysis as consisting of three flow activities: data reduction, data presentation, and drawing conclusions or verification (Dull and Reinhardt, 2014). Data obtained from the pilot experiment and teaching experiment in the experimental design were then analyzed retrospectively using data reduction and source triangulation. Data obtained during the research, in the form of audio recording documentation, were first transcribed, then the important parts were taken and the unimportant parts were removed. The important parts referred to are parts of the learning process related to the research. Then, the conversation transcripts were combined with other data, namely student work results and field notes for analysis. This analysis combined several different types of data and compared them with the assumptions in the HLT so that the resulting interpretation could be more precise.

Results and Discussion

This stage will describe teacher interviews and classroom observations. Both stages were conducted prior to the teaching experiment. Teacher interviews focused on the teacher's teaching methods in general and specifically in statistics, their knowledge of the realistic mathematics approach (RME), and how the students perceived the teacher. Meanwhile, classroom observations were used to observe the learning process and conditions.

Interviews with teachers identified subjects who would participate in the first cycle (small group) of learning. The interviews also identified several shortcomings in the learning process, such as difficulties in teaching material requiring illustrations and practice, a lack of mathematics textbooks for students, and monotonous lecture-based learning. The researcher's observations revealed several shortcomings in the learning process, such as students being inactive, not focusing on the teacher's explanations, and not all students participating in group work.

From the interviews and observations, it can be concluded that students in the class have varying characteristics during learning. During the three lesson hours (JP), contexts

related to everyday life were not used, and the material was presented in an abstract format, such as directly providing formulas to students, which prevented them from understanding how to apply the formulas to problems.

After data collection, the researcher designed a Hypothesis Learning Trajectory (HLT) and Student Worksheets (SW) to be used in the teaching experiment. The was created as part of the learning cycle used in the teaching experiment and will be continuously refined and adjusted throughout the research process. Table 1 shows the context used in studying statistics.

Table 1. The context of learning statics

No.	Material	Context used
1.	Measure of data centralization	Time spent by students using their favorite social media (Tiktok, Instagram and Whatsapp)
2.	Size of data location	The amount of time students spend using social media during a week is 21 hours
3.	Size of data distribution	The amount of time women spend using social media is more than men

The students' initial abilities in this study were needed to assess their understanding of statistics. These initial abilities were obtained from discussions with the 11th grade Mathematics teacher. This overview of the students' initial abilities was used for the small group cycle. Of the 21 students in 11th grade F2, 6 were selected. The students' statistical abilities are as follows:

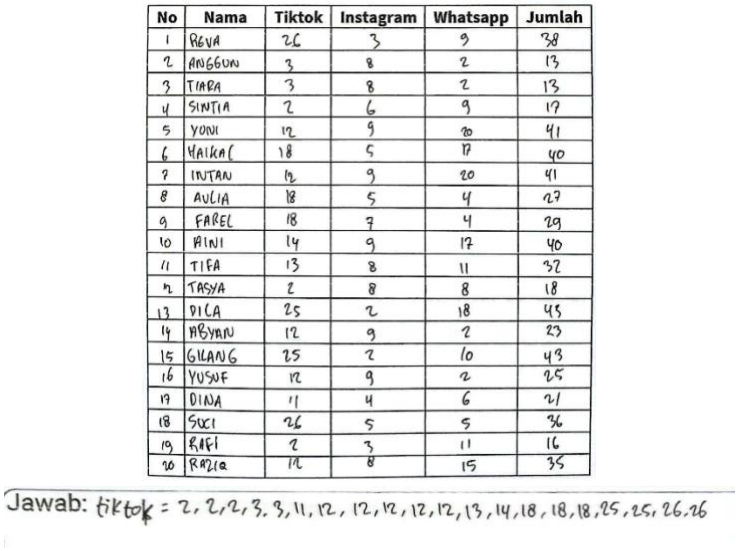
1. Sorting data from smallest to largest, and vice versa.
2. Presenting data in tables, graphs, and diagrams.
3. Reading data in graphs and diagrams.
4. Determining cumulative frequency values.
5. Determining measures of central tendency (mean, mode, and median) from single data and measures of dispersion (highest, lowest, and range).
6. Converting single data into grouped data.

The next section will discuss in detail the results of the teaching experiment that took place over three meetings. This section is a retrospective analysis created to compare what was designed in the Hypothesis Learning Trajectory (HLT) and what occurred in the field, which can be called the Actual Learning Trajectory (ALT). The comparison between the HLT and ALT is carried out to determine whether the expected goals were achieved or not, which can be seen through the results of student work on the Student Worksheet (SW) and

in class discussions, and to analyze whether the designed assumptions are the same or not as what occurred in the fi.

This first meeting consisted of just one activity aimed at reminding students of the data processing they had learned in 10th grade, namely determining measures of central tendency. In this first activity, students used single data to find the mean, median, and mode. They then used this data to find the mean, median, and mode of grouped data by converting the single data into grouped data. This grouped data was used to complete the table provided in the Student Worksheet (SW). In this first meeting, the for model used was the amount of time students spent using their favorite social media platforms. The data was presented in tabular form. Therefore, the off model found was the formula for finding the average (mean), median, and mode.

In SW 1.1, students were asked to rank the data on the amount of time spent on social media platforms during the week from smallest to largest. None of the five groups formed had any difficulty sorting the data. Picture 1 shows the students' responses.



No	Nama	Tiktok	Instagram	Whatsapp	Jumlah
1	REVA	26	3	9	38
2	ANGGUN	3	8	2	13
3	TIARA	3	8	2	13
4	SINTIA	2	6	9	17
5	YONI	12	9	20	41
6	HAIKAL	18	5	17	40
7	INTAN	12	9	20	41
8	AULIA	18	5	4	27
9	FAREL	18	7	4	29
10	AINI	14	9	17	40
11	TIFA	13	8	11	32
12	TASYA	2	8	8	18
13	DICA	25	2	18	45
14	ARYAN	12	9	2	23
15	GILANG	25	2	10	43
16	YUSUF	12	9	2	25
17	DIDA	11	4	6	21
18	SUCI	26	5	5	36
19	RAFI	2	3	11	16
20	RAZIA	12	8	15	35

Jawab: tiktok = 2, 2, 2, 3, 3, 11, 12, 12, 12, 12, 12, 13, 14, 18, 18, 18, 25, 25, 26, 26

Figure 1. Group 5 Answers Model For Sorting Data

Furthermore, in SW 1.1, students are asked to find the mean, median, and mode values of the sorted data without using a realistic mathematical approach because students have studied the mean, median, and mode in grade X. From the five groups, it seems they have the same answer, only the way of finding it is different. The following is answers from students.

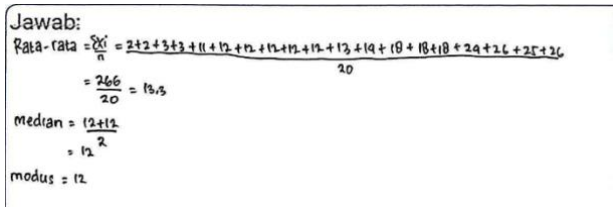


Figure 2. Mean, Median and Mode Values Group 2

In the second question, students were asked to complete a table of means, medians, and modes for grouped data. This table is used to find the mean, median, and mode values. Of the five groups working on the worksheet, it appears that students had no difficulty completing the table. The following student responses.

Tabel mencari nilai rata-rata (mean)

Interval	Frekuensi (f_i)	Titik Tengah (x_i)	$f_i \times x_i$
2-6	3	4	20
7-11	1	9	9
12-16	7	14	98
17-21	3	19	57
22-26	4	24	96

Tabel mencari median

Interval	Batas Bawah (L_i)	Panjang Kelas (p)	Frekuensi (f_i)	Frekensi Kumulatif (F_k)	$\frac{\frac{1}{2}n - F_k}{f_i}$	$L_i + p(\frac{\frac{1}{2}n - F_k}{f_i})$
2-6	1,5	5	5	5	2	13
7-11	6,5	5	1	6	45	57,5
12-16	11,5	5	7	13	0,45	8,25
17-21	16,5	5	3	16	-1	-21,5
22-26	21,5	5	4	20	-1,5	-39,75

Figure 3. Group 1 Model For Answers Completing the Table

When asked to summarize the difference between the mean of a single data set and the mean of a grouped data set, the answers varied. Some said the mean of a single data set was the same as the mean of a grouped data set, while others said the mean of a single data set was more accurate, while the mean of a grouped data set was more practical. The following student responses.

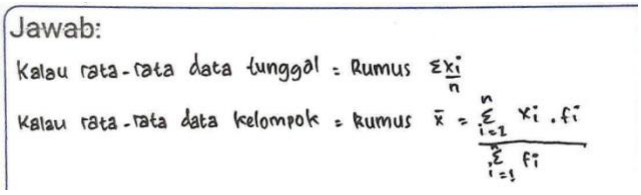


Figure 4. Group 2 Answers Model Off Differences in Mean of Single Data and Group Data

In question 4, the question was directed at determining which value was the median after completing the table. The answers varied. Groups 1, 2, 4 and 5 stated the median value

by referring to the median formula for group data, while Group 3 stated the last value from the table because it was an even number. The following student answers.

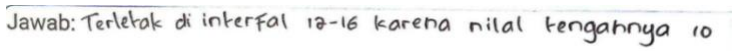


Figure 5. Group 3 Answers Median Group Data

In question 5, students were asked to determine which value was the mode from the provided table. The five groups that answered the worksheet showed similar answers, arguing that the mode is the value that appears most frequently. The following student answers.

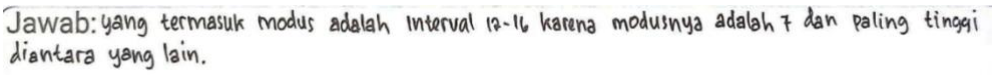


Figure 6. Group 2 Answers Group Data Mode

Of the five questions each group worked on, they stated that they did not find it difficult to complete the table, which they considered to be very long and time-consuming. However, from the activities the students carried out, it can be seen that all learning objectives for that day were achieved. When reviewed from the teaching applied, shortcomings encountered during teaching, the results of student work on the Student Worksheet (SW), the comparison of student reactions between the Hypothesis Learning Trajectory (HLT) and the Actual Learning Trajectory (ALT), and the achievement of the objectives of the first meeting, there were several things that needed to be suggested for improvement. The improvements in question included the addition of suspected student reactions to the HLT that were previously designed. The following Table 2 compares the and ALT problems.

The second session consisted of two activities that guided students in exploring the concept of location measures in data. The for model used in this second session was a dot plot graph. This dot plot graph was used in learning activities, resulting in the resulting off model consisting of formulas for finding location measures, such as quartiles, deciles, and percentiles for single and grouped data.

Students were introduced to a graph they had never encountered before: the dot plot. In the first activity, the researcher first introduced the dot plot using the context of body weight (kg) presented on the board. Next, the researcher wrote the dot plot scale and explained that there were red and blue circles. Afterward, the researcher asked about the information contained in the graph, sparking a discussion.

Table 2. Comparison of HLT and ALT first learning trajectory

No.	Task	HLT	ALT
1.	Based on the existing data on the amount of time that class XI F1 students spend using social media during the week, what social media do your friends use the most?	Add up each of the application data.	In general, students first add up each social media media used, by looking at the largest number, students say the TikTok application is the one most used by their friends.
		Mention the amount of time for each application and conclude which social time is used the most by students.	
2.	Based on the data on the amount of time students spend using TikTok, try to sort the data from smallest to largest.	Students sort the data on the amount of time students spend using TikTok from smallest to largest.	Students sort the data from smallest to largest.
3.	Find the average, median and mode values of the existing data.	Find the mean and median using the formula and state the mode value directly.	When looking for the mean value, students use the formula they learned in class X. When looking for the median value, students cross out one by one and leave the value in the middle.
4.	Complete the table to make it easier for you to find the average (mean), median and mode.	Students will not find it difficult because the instructions given are clear in the SW and what is provided is also clear in the SW.	The students' answers were almost all the same. However, some were less thorough, resulting in different results.
5.	Distinguishing the average (mean) of single data from odd data.	Students will differentiate it from the formulas they find.	Students say that the mean of single data is more accurate, the mean of group data is more practical.
		Students differentiate from the results they find.	Differentiate between the single data mean formula and the group data mean formula.
		Students will differentiate it from the process of searching for it.	The mean of a single data set is the same as the mean of a group data set.
6.	Memilih mana yang termasuk median dari tabel yang telah dilengkapi.	Siswa menggunakan rumus median data tunggal untuk melihat nilai tengah dari semua interval.	View the median formula for group data by finding the middle value of the data.
			Look at the even result and say that's the median.

No.	Task	HLT	ALT
7.	Membedakan modus untuk data tunggal dengan modus data kelompok.	Siswa akan membedakannya dari rumus yang mereka temukan. Menyebutkan modus dengan pengertian yang sama yaitu nilai yang sering muncul.	Students say the mode is the largest frequency value in the table.

The lesson continued with the core of the first activity, with the researcher demonstrating several social media applications such as TikTok, Instagram, and WhatsApp. The researcher explained to the students that an internet article stated that Indonesians typically spend 3 hours a day on social media, meaning Indonesians spend 21 hours a week on social media. The researcher then showed students data on the duration of their weekly social media use (Tiktok, Instagram, and WhatsApp) contained in five copies of the class data sheets (the data was identical) and explained that the article would be verified. Before completing Student Worksheet (SW) 2.1, the researcher showed students lottery tickets to determine how much data they could collect. Each group had the same number of data points, 9.

In the first question, after students were asked to present their data in the form of a dot plot graph (see Picture 7).

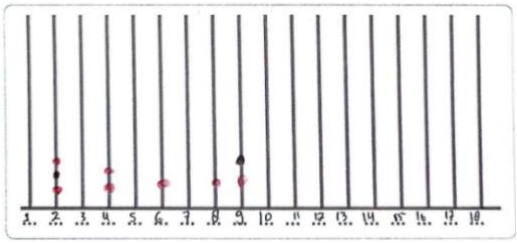


Figure 7. Group 3 Answers Model For Dot Plot Graph

Next, students were asked to divide the data into four equal parts and deduce how to obtain these four parts. The researcher guided students to discover the concept of quartiles. They divided the data into four parts by first finding the median. Next, they found the middle value to the left of the median and the middle value to the right of the median. Some also immediately found a formula for dividing the data from the graph into four equal parts. The following student answers.

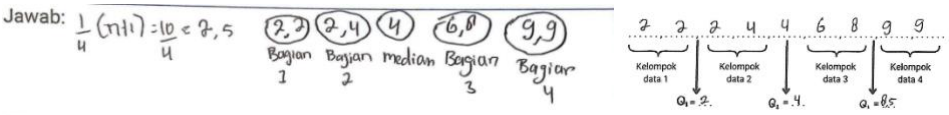


Figure 8. Group 3 Answers Model Off About Quartile Values

In question number 2, the researcher directed the students to find the concept of deciles from the dot plots they created. The researcher directed the students to divide 10 data points using the concept of quartiles. From the existing dot plot data, the students were directed to find the concept of deciles. All five groups were able to find the concept of deciles by swapping the divisions in the quartile formula. The following student answers.

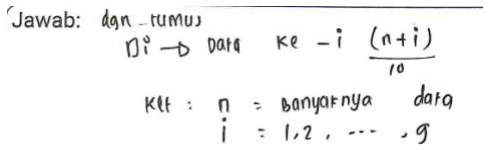


Figure 9. Group 1 Answers Model Off About Deciles

In question 3, students were led to discover the concept of percentiles. When solving the percentile problem, all groups could only find the percentile location. Students were confused about how to find the percentile value. The following student answers.

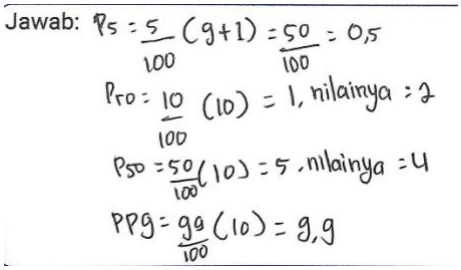


Figure 10. Group 3 Answers Model Off Percentile Concept

From the first activity, it was concluded that students were able to identify the concept of location in single data sets. Students tended to use their previous knowledge of the median to find the location. This second activity began with the researcher presenting a dot plot of the amount of time students spent using social media (Tiktok, Instagram, WhatsApp) for grade XI F1 during the week.

Then, the researcher presented the group data from the dot plot on the board and distributed Student Worksheet 2.2 and asked students to complete it. First, the researcher asked students to copy the group data into the Student Worksheet. Next, students were asked to complete the quartile table for the group data provided in the Student Worksheet. Picture 11 shows the students' answers below.

Interval	Batas Bawah (L_i)	Panjang Kelas (p)	Frekuensi (f_i)	Frekensi Kumulatif (F_k)	$L_i + p(\frac{\frac{1}{4}n - F_k}{f_i})$	$L_i + p(\frac{\frac{2}{4}n - F_k}{f_i})$	$L_i + p(\frac{\frac{3}{4}n - F_k}{f_i})$
13-17	12.5	5	4	4	18.7	25	31,25
18-22	17.5	5	2	6	20	32.5	45
23-27	22.5	5	3	9	47.8	29.11	37,5
28-32	27.5	5	2	11	55	30	42.5
33-37	32.5	5	2	13	55	30	42.5
38-42	37.5	5	5	18	44.5	30.5	39.5
43-47	42.5	5	2	20	47.5	22.5	35

Figure 11.. Group 4 Model For Answers Completing the Quartile Table

In question 2, students were asked to identify the upper quartile, median, and lower quartile. Students answered using their prior knowledge of quartiles in single data by dividing the data into four parts. The following student answers.

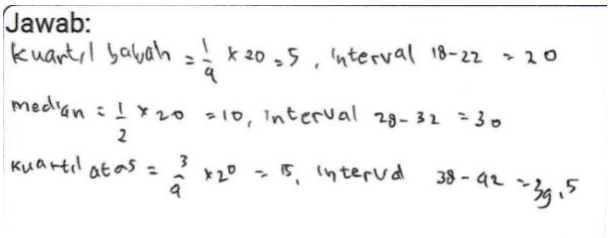


Figure 12. Group 5 Answers Model Off Finding Quartile Values

In question 3, students were asked to identify the differences between the quartile, decile, and percentile formulas from the completed table. When asked what differentiates quartiles, deciles, and percentiles, all students answered with the word division. Students were asked to identify the decile and percentile formulas for grouped data using the quartile formulas they had obtained. The following Picture shows student answers.

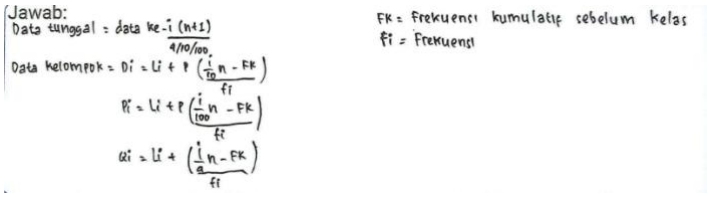


Figure 13. Group 2 Answers Model Off Finding Decile and Percentile Formulas

From their answers on how to differentiate quartiles, deciles, and percentiles, it can be concluded that students are able to determine quartiles, deciles, and percentiles for grouped data, as well as distinguish between quartiles, deciles, and percentiles. By simply completing the quartile table, students can discover the concepts of deciles and percentiles. Research at this third meeting showed that what happened in the HLT was the same as the ALT. The following table 3 shows a comparison of the HLT and ALT at the second meeting.

Table 3. Comparison of HLT and ALT second learning path

No.	Task	HLT	ALT
1.	When dividing the data into 4 parts to find the quartiles.	Students divide the data by finding the middle value for each part.	Students use the quartile formula to divide the data into 4 parts.
		Using the quartile formula.	Find the middle value first, then look for the two middle values to the right and left of the median of the data.
2.	When finding the concept of deciles from the dot plot created.	Students do not know how to find the decile because the data only consists of 9 while the decile divides the data into 10 equal parts.	Students divide the data into 10 parts following the concept of quartiles that they discovered.
		Because students know that the decile division is 10 parts, students use the quartile formula and change the division to 10.	
3.	Find the Percentile concept from the given dot plot by dividing the data into 100 equal parts.	The student concluded that it was impossible to divide the data into 100 parts because the data given only amounted to 100.	Students divide the data into 100 parts using the concept of quartiles that they discovered.
		Students use linear interpolation to find percentile values.	
		Because students know that the percentile division is 100 parts, students use the quartile formula and change the division to 100.	
4.	Completing the quartile table.	Students have no difficulty in completing the table.	With the help of a calculator, students completed all the tables without any problems, there were only a few tables where the students' answers differed between groups.
5.	From the existing table, which are included in the lower	With the skills in the first activity, students divide the 4 data and then see the results	Students divide the 4 data like single data quartiles in the first activity.

No.	Task	HLT	ALT
	quartile, middle quartile and upper quartile?	from the cumulative frequency. Students use the median formula for group data that was studied in the previous meeting by replacing the i value according to the quartile asked.	
6.	Define the concepts of deciles and percentiles.	Because students already know the difference between quartiles, deciles and percentiles, in the first activity, students only change the division.	Students define the concepts of deciles and percentiles by utilizing the formulas for quartiles in grouped data. Because they understand the difference between quartiles, deciles, and percentiles lies in their division, they simply change the divisor.

This third meeting consists of two activities that guide students to discover the concept of data distribution measures. The for model in this third meeting is that female students use social media more than male students. Data from each female student is separated from the male data. So that at the end of the learning or off model of this third meeting, students discover the concept of data distribution measures in the form of formulas for finding range and deviation. In the first activity, the researcher began the learning by conveying the context first, namely the same amount of time students spend on social media (Tiktok, Instagram and WhatsApp) during the week in hours. Next, the researcher explained that the data to be used are two: data from female students in class XI F1 and data from male students in class XI F1. However, there is a difference in the distribution of the data to be used where the odd-numbered groups work on data from female students and the even-numbered groups work on data from odd-numbered students. The following Picture 14 represents the students' answers.

Nama	Perempuan	Laki-Laki
Reva	30	-
Anggun	13	-
Tiara	13	-
Sinta	17	-
Rahma	41	-
Muhammad H	-	40
Iman	41	-
Nulia	-	27
Farel	-	29
Rahman	40	-
Wasiatul	32	-
Wakaiks	18	-
Dita	43	-
Abyan	-	23
Gilang	-	43
Yusuf	-	23

Figure 14. Group 1 Answers Model

In question one, students were asked to determine the range, interquartile range, and quartile deviation. In the worksheet, students were guided to find the range, interquartile range, and quartile deviation. Students found no difficulty in determining these values, so there was no discussion about finding the range. Following are the students' answers.

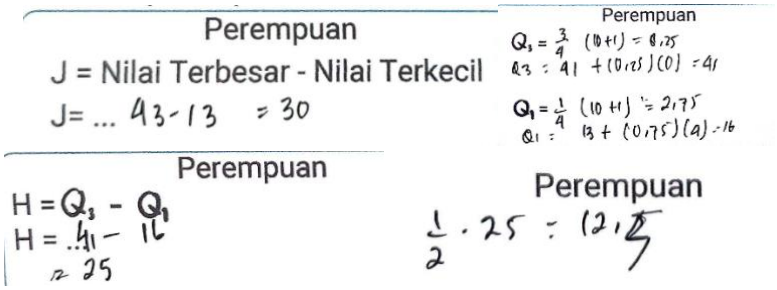


Figure 15. Group 1 Answers Model Off About Range

It can be concluded that in this first activity, to determine the range, interquartile range, and quartile deviation, students tended to compare data for women and men obtained from each different group and memorized the graphs and information obtained. In this second activity, they will discover the concepts of mean deviation, variance, and standard deviation for single and grouped data. For single data, students were guided to discover the concepts, while for grouped data, students were asked to complete a table to find the mean deviation, variance, and standard deviation. Before beginning this second activity, the researcher briefly explained absolute value.

In the first question, students were asked to find the mean deviation for a single data set. For the mean deviation for grouped data, students will convert the single data set into grouped data. Of the five groups, three groups found the mean deviation. The rest also struggled with calculating absolute value. The following student responses.

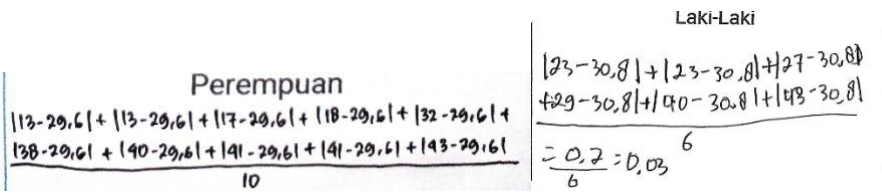


Figure 16. Answers for Group 2 and Group 4 Off Model Finding the Average Deviation Value

When finding the mean deviation from the data, the student groups completed the provided table. Of the five groups, two were able to complete the table. The other group did not understand the concept of absolute value, resulting in negative answers. The following student answers.

Interval	Frekuensi (f_i)	Nilai Tengah (x_i)	$\|x_i - \bar{x}\|$	$f_i\|x_i - \bar{x}\|$
23-29	4	26	4,8	19,2
30-36	0	33	2,2	0
37-43	2	40	9,2	18,4
Jumlah $\sum_{i=1}^{n}$	6			37,6

Figure 17.. Group 2 Model Answers for Completing the Mean Deviation Table

In question 2, students were asked to find the variance and standard deviation values for single and grouped data. For single data, students were guided to discover the concept of variance. For grouped data, students were asked to complete a table to help them understand the concept of variance. While working on the variance of single data, several groups failed to square their values, resulting in errors in finding the variance value. Meanwhile, group 1 answered the question correctly. The following student answers.

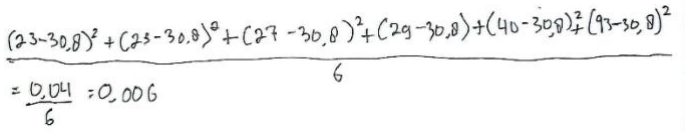


Figure 18. Model Off Group Answer 4 Variance Results

Meanwhile, the concept of variance for student group data completes the table. It can be seen that all student groups experienced no difficulty at all. Students understood the variance of group data better than single data. The answers in the table for each group were also similar. The following student answers.

Interval	Frekuensi (f_i)	$(x_i - \bar{x})$	$(x_i - \bar{x})^2$	$f_i(x_i - \bar{x})^2$
23-25	4	-4,5	25,04	92,16
30-36	0	2,2	4,84	0
37-43	2	9,2	84,65	169,28
Jumlah $\sum_{i=1}^{n}$	6			261,44

Figure 19.. Group 4 Model For Answers Completing the Variance Table

When viewed from the teaching applied, the shortcomings obtained during teaching, the results of student work on the Student Worksheet (SW), the comparison of student reactions between the Hypothesis Learning Trajectory (HLT) and the Actual Learning Trajectory (ALT), and the achievement of the objectives of the first meeting, there are several things that need to be suggested for improvement. Such as making a simpler example of absolute value so that it can be understood more easily, the use of the context of male and female data is less appropriate because this material is new to students so that words such as variety or variance and standard deviation feel foreign to students and additional assumptions When looking for variance values in single data. An addition to student assumptions is not squaring to find variance values, so the value obtained is wrong. The following table 4 compares HLT and ALT in learning path 3.

The researcher first designed a learning design consisting of three sessions within a single context. Each session included specific activities designed to achieve a desired goal and aligned with existing theoretical studies. In designing the lesson, the researcher used a single learning context, namely the amount of time students spend using social media (TikTok, Instagram, and WhatsApp) per week in hours. The design consisted of three sessions, with a total of six activities in the first cycle and five activities in the second cycle.

The learning in this first session focused on the concept of measures of central tendency (mean, median, and mode) for single and grouped data. According to Jean Piaget, (Piaget and Inhelder, 2015) Students construct knowledge based on their experiences and interactions with their environment, with the teacher acting as a facilitator, not a transmitter of information. Therefore, based on this learning theory, the context used is appropriate to the students' realities. In this session, the researcher divided the session into a single activity, focusing on the concept of measures of central position (mean, median, and mode) for single and group data. However, in its implementation, a context relevant to the students' lives is essential. The context relates to the amount of time students spend using their preferred social media platforms during the week. The context in the first session will influence

subsequent sessions. The choice of context is crucial because it connects the expected objectives between the first and subsequent sessions. Changing the context would waste time, forcing students to try to understand new phenomena.

Table 4. Comparison of HLT and ALT first learning trajectory

No.	Task	HLT	ALT
1.	Determine the range, interquartile range and quartile deviation.	Find the range by subtracting the largest data and the smallest data from the data. To find the interquartile range by finding the difference between the upper quartile and the lower quartile. To find the quartile deviation by dividing the interquartile range by 2.	To find the range, find the largest difference between the values. To find the interquartile range, students find the difference between the highest and lowest quartiles. To find the interquartile deviation, students divide the quartile range by two.
2.	Finding the average deviation of a single data set.	Follow the steps in the SW. Using absolute value to find the mean deviation.	Some students had difficulty but students succeeded in finding the average deviation value from the data provided.
3.	Find the average deviation of group data.	Complete the table provided to find the average deviation.	Students complete the table and find the average deviation value according to the steps in the SW.
4.	Finding the concept of variance in single data.	Solve variance problems by following the steps provided. Students do not experience difficulties in understanding words that can lead students in finding the concept of variance so that they succeed in finding the variance value correctly.	Students do not square to find the variance, so the value obtained is wrong.

The second session consisted of two activities. In the first, the researcher provided several data sets to each group, and students were asked to identify the concept of measures of central position and differentiate between quartiles, deciles, and percentiles using a dot plot graph. In the second activity, the researcher used a class-wide dot plot graph, which was then converted into a group data set. Research conducted by Suzanne (Fox, 2013) dot plots help students understand statistical concepts. To implement these two activities, the context and design of the meeting play a significant role in ensuring meaningful learning for students. The researcher designed the third meeting by adding a dot plot graph, which the students were unfamiliar with.

The third meeting consisted of two activities: the first focused on range. Three groups worked on data on women, while the other two groups worked on data on men. This is based on an article found (Maiben, 2021) that females spend more time on social media than males. Meanwhile, in the second activity, students will learn about single and group data deviations. The purpose of using context in this third meeting is to investigate the claim that female students spend more time on social media than male students in grade XI F1. In this lesson, the role of context and design will be examined in learning. The context in the third meeting was not problematic, but there were challenges with the design that needed improvement. The challenges lay in other material that students had not yet mastered, namely the use of absolute values. This created difficulties when dealing with absolute values. Students appeared hesitant to express their opinions, despite the researcher's efforts to encourage students to be more active in critiquing their peers' presentations in front of the class.

Overall, the concepts learned included measures of central tendency, measures of location, and measures of data dispersion, which were discussed in the three meetings. Students also learned several new concepts, including dot plot graphs. The role of the design context certainly has its own advantages and disadvantages in practice. However, when viewed as a whole, the role of context and design can be applied throughout the learning process.

Conclusion and Suggestion

The context used is the amount of time students spend using social media (TikTok, Instagram, and WhatsApp) during a week in hours. In general, the context used can influence students' understanding of each problem in the Student Worksheet (SW) regarding a phenomenon close to their daily lives. In this section, the mathematization process occurs when the context is applied. Based on the conclusions put forward by the researcher, a local instructional theory was formed.

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