Statistics for Educational research

Asst. Prof. Dr. Wannaporn Siripala

Statistics is an important factor in doing research. Researchers must have knowledge of the types of statistics used in research, methods of data analysis that are consistent with the objectives and hypotheses of the research.

Statistics refers to a branch of mathematics that deals with statistical principles and methods used in data collection, organization and presentation, data analysis, interpretation, conclusions, and decision-making based on the principles of probability as an important foundation.

Statistic means numerical values that are calculated from a sample or a large amount of data. It means numerical values that are calculated from a sample or a large amount of data to show certain facts and meanings, such as the arithmetic mean ($\bar{X}$), etc.

Type of statistics

1. **Descriptive Statistics**

It is a statistic that uses all available data, which may be a population or a sample. The results of this analysis are not intended to be generalized to other groups, but rather to explain the conclusions or characteristics of the data of that group only. Statistics obtained from data analysis or refer to statistics used to describe facts of the data we have collected, for example, a teacher found the average weight of female students in Grade 2 to be 35 kilograms. This teacher cannot conclude by citing that the average weight of female students in the Grade 2 in other classes is 35 kilograms.

The analysis focuses on explaining the conclusions or characteristics of the group of data. The description of the facts of the collected data. The statistics used are: tables, bar charts, picture charts, various graphs – pie charts, bar charts, histogram, boxplot, frequency, percentage, finding the middle value or the value that is the central tendency, such as Arithmetic Mean (Average), Median, Mode, Measures of Variation or Dispersion, such as Variance, Standard Deviation, Percentile, Quartile, coefficient of variation, Skewness, Peakedness or Kurtosis, etc.

2. **Inferential Statistics**

Refers to statistics that analyze data collected from a sample group to explain some characteristics of the population and test hypotheses based on the principle of probability.

Statistics used:

1. Z-test and t-test (Independent t-test, Paired t-test)
2. Analysis of Variance: ANOVA
3. Chi – Square Test
4. Regression and Correlation
5. Discriminant Analysis
6. Nonparametric Test
7. Factor Analysis
8. Cluster Analysis
9. Logistic Regression Analysis
10. Multivariate ANOVA

Inferential statistics used in educational research are used in cases of comparing academic achievement according to the teaching methods of interest. In this case, it is used t-test but can be classified into 2 cases:

Case 1: Single classroom using the teaching method of interest, steps in using statistics and data collection

Step 1 Pre-test

Step 2 Conduct teaching according to the specified method or interest

Step 3 Post-test (The test is the same of pre – test)

Step 4 Survey about student satisfaction

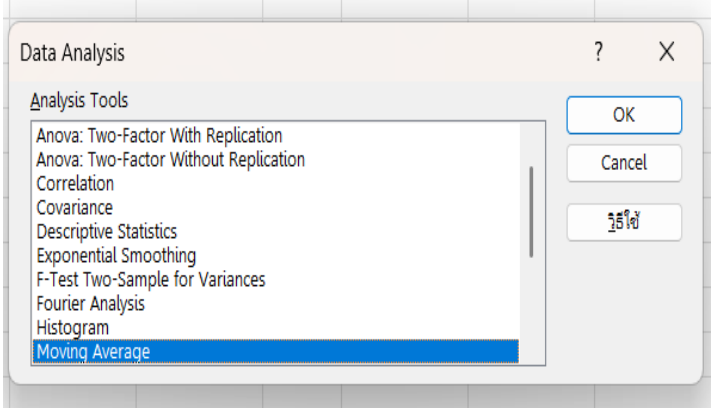
Step 5 Interview students about new method of teaching

The statistics used to compare the learning achievement results before and after learning are: t-test dependent variable. When using a program, you can use the command t-test paired two sample for means. Data analysis is based on values t-test and prob.

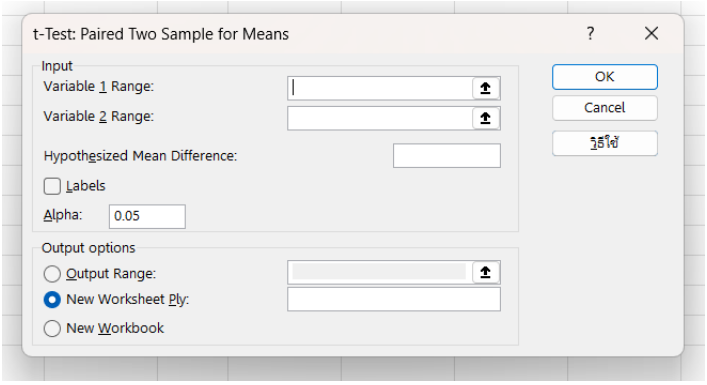
How to test one sample

No.	before-learn	after-learn
1	7	18
2	8	16
3	7	15
4	9	17
5	8	18
6	7	13
7	6	15
8	8	16
9	7	17
10	9	18
11	8	14
12	7	13
13	8	16
14	8	15
15	7	14
16	7	13
17	9	15
18	8	16
19	8	17
20	8	17
Mean	7.7	15.65
Standard Deviation	0.80	1.66

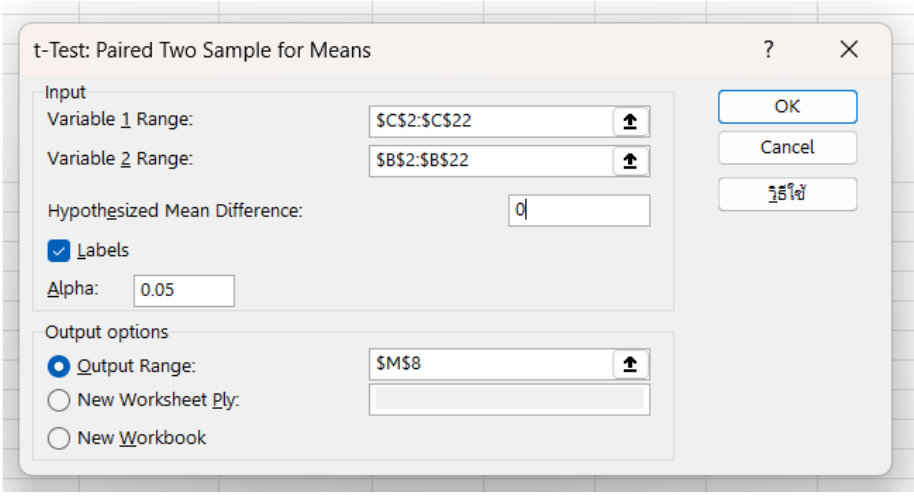
Step 1 select data analysis from tool data



Step 2 select t-Test Paired Two Sample for Means



Step 3 select column after-learn in variable 1, column before-learn in variable 2, hypothesized mean difference = 0, click labels and cell in output range



Step 4 analyze and interpret

t-Test: Paired Two Sample for Means

	after-learn	*before-learn*
Mean	15.65	7.7
Variance	2.77	0.64
Observations	20	20
Pearson Correlation	0.43	
Hypothesized Mean Difference	0	
df	19	
t Stat	23.65	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.73	
P(T<=t) two-tail	0.00	
t Critical two-tail	2.09	

t Stat = 23.65

$t_{.05,19} = 1.73$

t Stat = 23.65 > $t_{.05,19} = 1.73$

P(T<=t) one-tail = 0.00

It means reject research hypothesis or write research hypothesis is significant.

Average after learn by… (new method of teaching) … more than average before learn by … (traditional) ….

Case 2: Two classrooms, divided into a control room and an experimental room (using the teaching method of interest or new method of teaching). Steps in using statistics and data collection.

Step 1 Pre-test: Test before learn both classes using the same test set.

Step 2: Teaching in the control room: Use the original teaching method. In the experimental room: Use the method of interest or new method of teaching.

Step 3 Post-test: Test after learn both classes using the same test set.

Step 4: Survey about the satisfaction of students in both classes.

Step 5: Interview some students to support the research

Statistics used to compare the academic achievement results after studying in both classes.

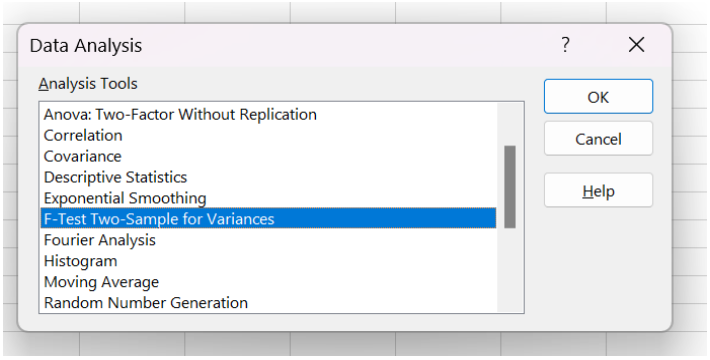
Example class 1 and class 2, you have pre-test and post-test of class1 and class2

	class 1		class 2	
No.	pre-learn class 1	after-learn	pre-learn class 2	after-learn
1	7	18	6	12
2	8	16	7	13
3	7	15	6	14
4	9	17	5	12
5	8	18	4	15
6	7	13	6	14
7	6	15	5	13
8	8	16	4	12
9	7	17	6	14
10	9	18	7	12
11	8	14	6	13
12	7	13	7	11
13	8	16	6	12
14	8	15	7	13
15	7	14	7	14
16	7	13	6	13
17	9	15	5	12
18	8	16	5	11
19	8	17	6	13
20	8	17	7	14

Step 1: Compare the variance between the experimental and control rooms by selecting F-test Two-Sample for variances

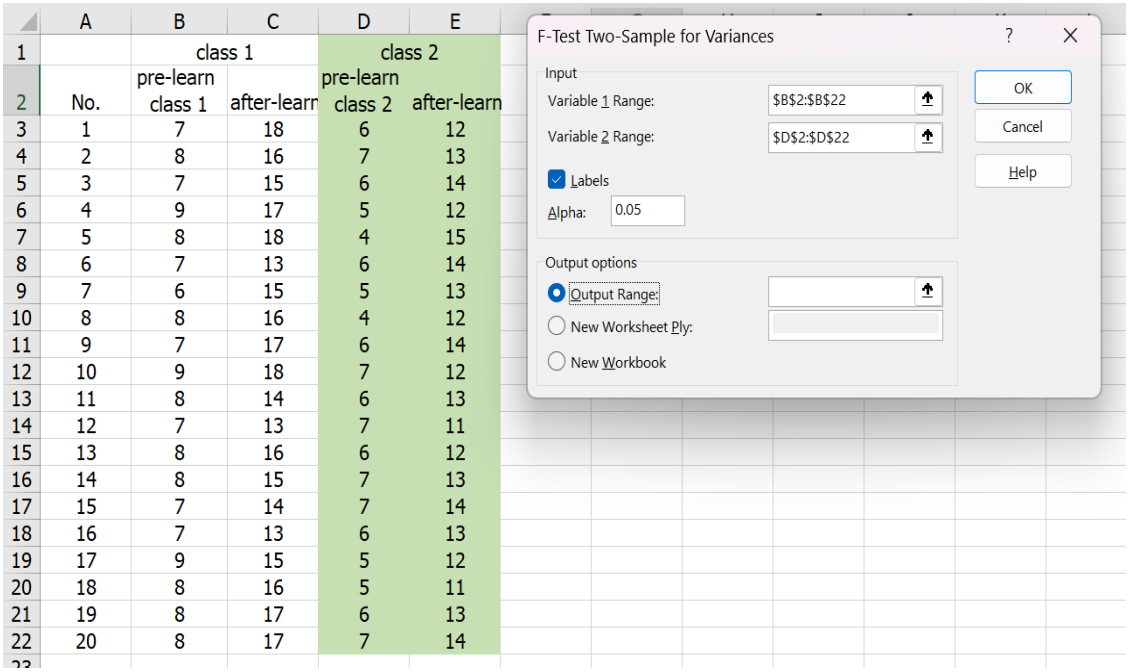
We compare variances for select t-Test between t-Test equal variance and t-Test unequal variance

Select F-test Two-Sample for Variances from Data Analysis



σ_{b1}^2 : variance of before learn class 1

σ_{b2}^2 : variance of before learn class 2



	A	B	C	D	E
1		class 1		class 2	
2	No.	pre-learn class 1	after-learn	pre-learn class 2	after-learn
3	1	7	18	6	12
4	2	8	16	7	13
5	3	7	15	6	14
6	4	9	17	5	12
7	5	8	18	4	15
8	6	7	13	6	14
9	7	6	15	5	13
10	8	8	16	4	12
11	9	7	17	6	14
12	10	9	18	7	12
13	11	8	14	6	13
14	12	7	13	7	11
15	13	8	16	6	12
16	14	8	15	7	13
17	15	7	14	7	14
18	16	7	13	6	13
19	17	9	15	5	12
20	18	8	16	5	11
21	19	8	17	6	13
22	20	8	17	7	14

Input: Variable1 Range select column pre-learn class1 and Variable 2 Range select column pre-learn class2

Label: It helps to read variable. Example you will select B2:B22. It covers name of variable: pre-learn class1.

Alpha writes 0.05. For confidence about signification, you will select 0.05, 0.01 and 0.10. Everyone selects 0.05.

Output Range: You can select cell in this sheet, it's easy to interpret.

$H_0 : \sigma_{b1}^2 = \sigma_{b2}^2$

$H_1 : \sigma_{b1}^2 \neq \sigma_{b2}^2$

F-Test Two-Sample for Variances

	pre-learn class 1	*pre-learn class 2*	
Mean	7.7	5.9	
Variance	0.64	0.94	
Observations	20	20	
df	19	19	=20-1
F	0.69		
P(F<=f) one-tail	0.21		
F Critical one-tail	0.46		

$F \geq Fcritical$ will reject $H_0 : \sigma_{b1}^2 = \sigma_{b2}^2$ show that $H_1 : \sigma_{b1}^2 \neq \sigma_{b2}^2$

$F < Fcritical$ will accept $H_0 : \sigma_{b1}^2 = \sigma_{b2}^2$

summarize $F \geq Fcritical$ show that $H_1 : \sigma_{b1}^2 \neq \sigma_{b2}^2$

0.69 > 0.46

formula t -test unequal varaince

Mean pre-learn class 1 = 7.7

Mean pre-learn class 2 = 5.9

Observation means number of each class = 20

df. = 20 – 1 = 19

F-value = 0.69 F critical one tail = 0.46

F-value (F compute) = 0.69 > F critical one tail (F-Table) = 0.46

It's meaned reject H_0 and accept H_1

$H_1 : \sigma_{b1}^2 \neq \sigma_{b2}^2$

From the result you will select t-Test unequal variances:

Step 2: Compare the mean (average) between the experimental and control rooms by selecting t-Test Two-Sample

From the data, we will use t-Test unequal variance

Example: How to compute t-Test unequal variances

	class 1		class 2	
No.	pre-learn	after-learn TGT	pre-learn	after-learn control
1	7	18	6	12
2	8	16	7	13
3	7	15	6	14
4	9	17	5	12
5	8	18	4	15
6	7	13	6	14
7	6	15	5	13
8	8	16	4	12
9	7	17	6	14
10	9	18	7	12
11	8	14	6	13
12	7	13	7	11
13	8	16	6	12
14	8	15	7	13
15	7	14	7	14
16	7	13	6	13
17	9	15	5	12
18	8	16	5	11
19	8	17	6	13
20	8	17	7	14

μ_{a1} :Mean of achievement after learn class 1-TGT

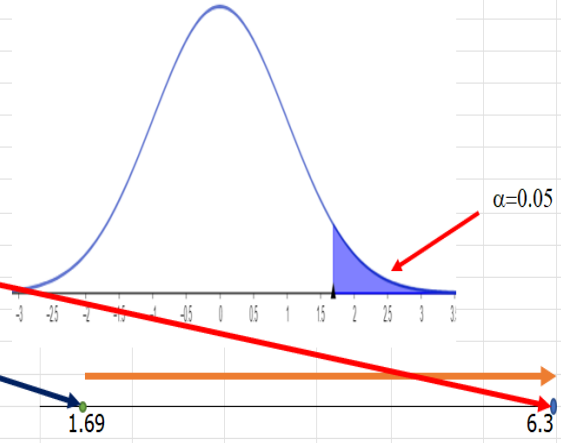
μ_{a2} :Mean of achievement after learn class 2 – control

$$H_0 : \mu_{a1} = \mu_{a2}$$

$$H_1 : \mu_{a1} > \mu_{a2}$$

t-Test: Two-Sample Assuming Unequal Variances

	after-learn TGT	*after-learn control*
Mean	15.65	12.85
Variance	2.77	1.19
Observations	20	20
Hypothesized Mean Differenc	0	
df	33	
t Stat	6.30	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.69	
P(T<=t) two-tail	0.00	
t Critical two-tail	2.03	



Mean after-learn class 1 = 15.65

Mean after-learn class 2 = 12.85

Observation means number of each class = 20

df. = 33

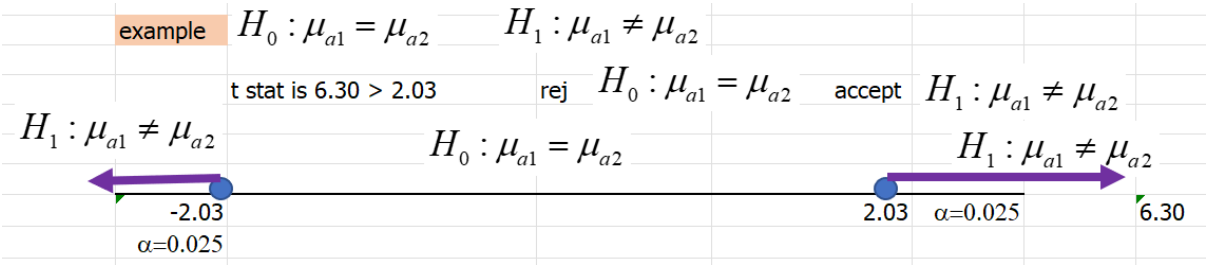
t-value = 6.30 t critical one tail = 1.69

t-value (t compute) = 6.30 > t critical one tail (t-Table) = 1.69

P(T<=t) one-tail = 0.00

Accept $H_1 : \mu_{a1} > \mu_{a2}$

Sometimes researchers want to study differences between means. They will use t-Test two tails.



Example: How to compute t-Test equal variances

This example has equal variances but the same score of after-learn between class 1 and class 2

	class 1		class 2	
No.	before-learn class 1	after-learn	before-learn class 2	after-learn
1	7	18	6	12
2	8	16	7	13
3	7	15	6	14
4	9	17	5	12
5	8	18	4	15
6	7	13	6	14
7	6	15	5	13
8	8	16	4	12
9	6	17	6	14
10	9	18	7	12
11	8	14	6	13
12	7	13	7	11
13	8	16	6	12
14	8	15	7	13
15	7	14	7	14
16	7	13	6	13
17	9	15	5	12
18	9	16	5	11
19	8	17	6	13
20	9	17	7	14
	7.75	**15.65**	**5.9**	**12.85**
	0.93	**2.77**	**0.94**	**1.19**

You can use the same formula to compute F-Test for compare two variances.

σ_{b1}^2 : variance of before learn class 1

σ_{b2}^2 : variance of before learn class 2

$H_0 : \sigma_{b1}^2 = \sigma_{b2}^2$

$H_1 : \sigma_{b1}^2 \neq \sigma_{b2}^2$

F-Test Two-Sample for Variances

	before-learn class 1	*before-learn class 2*
Mean	7.75	5.9
Variance	0.93	0.94
Observations	20	20
df	19	19
F	0.997	
P(F<=f) one-tail	0.498	
F Critical one-tail	0.461	

$F \geq Fcritical$ will reject $H_0 : \sigma_{b1}^2 = \sigma_{b2}^2$ show that $H_0 : \sigma_{b1}^2 = \sigma_{b2}^2$

$F < Fcritical$ will accept $H_0 : \sigma_{b1}^2 = \sigma_{b2}^2$

summarize $F < Fcritical$ show that $H_1 : \sigma_{b1}^2 \neq \sigma_{b2}^2$

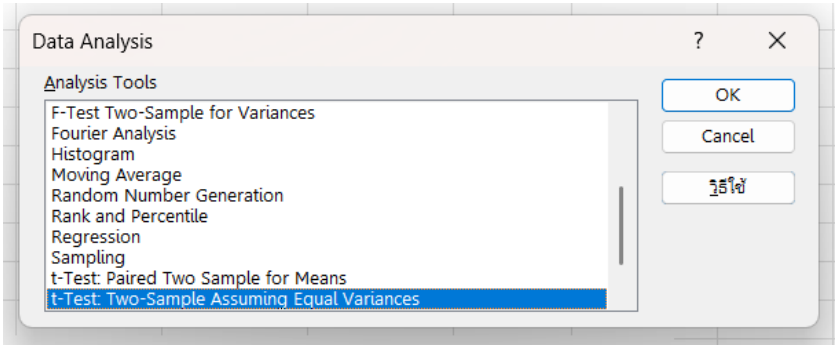
0.997 > 0.461

formula t -test equal varaince

From the data, we will use t-Test equal variance

Example: How to compute t-Test unequal variances

You will use t-Test Two-Sample Assuming Equal Variances



μ_{a1} :Mean of achievement after learn class 1-TGT

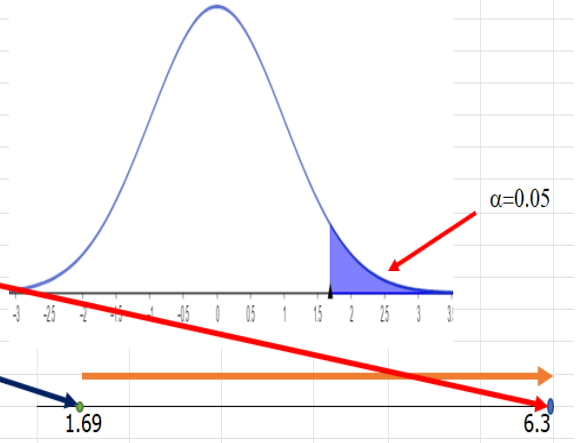
μ_{a2} :Mean of achievement after learn class 2 – control

$$H_0 : \mu_{a1} = \mu_{a2}$$

$$H_1 : \mu_{a1} > \mu_{a2}$$

t-Test: Two-Sample Assuming Unequal Variances

	after-learn TGT	*after-learn control*
Mean	15.65	12.85
Variance	2.77	1.19
Observations	20	20
Hypothesized Mean Differenc	0	
df	33	
t Stat	6.30	
P(T<=t) one-tail	0.00	
t Critical one-tail	1.69	
P(T<=t) two-tail	0.00	
t Critical two-tail	2.03	



rej H0 accept H1

Survey about student satisfaction

Case interpreted by Best

Likert scale to qualify the students' feedback.

Example 5 Likert scale

5 points for "strongly agree"

4 points for "agree"

3 points for "uncertain"

2 points for "disagree"

1 point for "strongly disagree"

The average of the expert opinion suitability ratings will be calculated and compared to the following scale: (Best, 1977)

Best, J. W. (1977). *Research in Education* (3rd ed.). Prentice-Hall.

Criteria to interpret

A mean score of 4.51-5.00 means “strongly agree” interpreted as = “very high.”

A mean score of 3.51-4.50 means “agree” interpreted as = “high”

A mean score of 2.51-3.50 means “uncertain” interpreted as = “moderate”

A mean score of 1.51-2.50 means “disagree” interpreted as = “low.”

A mean score of 1.00-1.50 means “strongly disagree” interpreted as “very low.”

Example interpreted by BEST

Table 1 Descriptive Statistics of Adolescent Time Management Disposition

No.	Item	Mean	Std. Deviation	Interpret
A1	The adage "an inch of time is worth an inch of gold" is, in my opinion, accurate.	3.43	1.21	Moderate
A2	It's true what they say: "Time is money."	3.68	1.14	High
A3	The time element is the first thing I have to think about in anything I do.	3.60	1.20	High
A4	I considered the past, present, and future to be less significant than the former.	3.51	1.21	High
A5	I'm young right now, so it doesn't really matter if I squander some time.	3.62	1.16	High
A6	Timing is crucial for everyone.	3.66	1.11	High
A7	Time, in my opinion, is life.	3.58	1.23	High
A8	Utilizing my time well is of great importance to me.	3.76	1.02	High
A9	I frequently impart to my classmates the value of managing their time well.	3.74	1.16	High
A10	I think time is power.	3.65	1.20	High

Case interpreted by range

Likert scale to qualify the students' feedback.

Example 5 Likert scale

5 points for "strongly agree"

4 points for "agree"

3 points for "uncertain"

2 points for "disagree"

1 point for "strongly disagree"

$$\text{Range} = \frac{\max - \min}{level} = \frac{5-1}{5} = \frac{4}{5} = 0.8$$

Criteria to interpret

A mean score of 4.21-5.00 means “strongly agree” interpreted as = “very high.”

A mean score of 3.41-4.20 means “agree” interpreted as = “high”

A mean score of 2.61-3.40 means “uncertain” interpreted as = “moderate”

A mean score of 1.81-2.60 means “disagree” interpreted as = “low.”

A mean score of 1.00-1.80 means “strongly disagree” interpreted as “very low.”

Example interpreted by range

Table 2 Descriptive Statistics of Adolescent Time Management Disposition

No.	Item	Mean	Std. Deviation	Interpret
A1	The adage "an inch of time is worth an inch of gold" is, in my opinion, accurate.	3.43	1.21	High
A2	It's true what they say: "Time is money."	3.68	1.14	High
A3	The time element is the first thing I have to think about in anything I do.	3.60	1.20	High
A4	I considered the past, present, and future to be less significant than the former.	3.51	1.21	High
A5	I'm young right now, so it doesn't really matter if I squander some time.	3.62	1.16	High
A6	Timing is crucial for everyone.	3.66	1.11	High
A7	Time, in my opinion, is life.	3.58	1.23	High
A8	Utilizing my time well is of great importance to me.	3.76	1.02	High
A9	I frequently impart to my classmates the value of managing their time well.	3.74	1.16	High
A10	I think time is power.	3.65	1.20	High

Statistics for educational research are related to the development of teaching methods that aim to solve the problem of student academic achievement in the classroom. The research tools therefore focus on the learning management plan, the test, and the questionnaire on opinions on the teaching methods. and the interview. Therefore, the statistics used are the calculation of the mean and standard deviation of satisfaction, the comparison of academic achievement with F-Test or t - Test as appropriate.