

# How do you calculate a paired sample t-test?

Authored by  
**stats writer**

June 23, 2024

## RECOMMENDED CITATION

stats writer (2024). *How do you calculate a paired sample t-test?*. PSYCHOLOGICAL SCALES. Retrieved from <https://scales.arabpsychology.com/?p=149346>

A paired sample t-test is a statistical test used to determine whether there is a significant difference between two related groups or variables. It is typically used when the same individuals or objects are measured twice, resulting in two sets of dependent data.

To calculate a paired sample t-test, the following steps are typically followed:

1. Determine the null and alternative hypotheses: The null hypothesis states that there is no significant difference between the two sets of data, while the alternative hypothesis states that there is a significant difference.
2. Calculate the difference between the two sets of data: Subtract the values of one set from the other to obtain a new set of differences.
3. Calculate the mean of the differences: Add all the differences and divide by the total number of differences.
4. Calculate the standard deviation of the differences: This measures the variability of the differences from the mean.
5. Calculate the t-statistic: This is calculated by dividing the mean difference by the standard deviation of the differences and then multiplying by the square root of the number of pairs.
6. Determine the critical value: This is the value that the t-statistic must exceed in order for the null hypothesis to be rejected.
7. Compare the t-statistic to the critical value: If the t-statistic is greater than the critical value, the null hypothesis is rejected and it can be concluded that there is a significant difference between the two sets of data.
8. Calculate the p-value: This is the probability of obtaining the observed t-statistic or a more extreme value if the null hypothesis is true. If the p-value is less than the chosen level of significance, the null hypothesis is rejected.

In summary, a paired sample t-test involves calculating the mean and standard deviation of the differences between two related sets of data and comparing the results to determine if there is a significant difference between them.

## Calculating Paired Sample t-test

**In this section, we will learn about calculating the**

**Paired Sample T-test.** To calculate it, we will take the Employee data set. In this data set, we have the id of employees, their gender, education, job category, current salary, and beginning salary.

Employee Data.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

	id	gender	educ	jobcat	salary	salbegin	jobtime	prevexp	minority
1	1	1	15	3	\$35,373	\$20,000	98	144	0
2	2	1	16	1	\$32,000	\$15,887	98	36	0
3	3	2	12	1	\$12,748	\$11,037	98	381	0
4	4	2	8	1	\$15,883	\$8,483	98	190	0
5	5	1	15	1	\$48,000	\$35,908	98	138	0
6	6	1	15	1	\$24,553	\$10,674	98	67	0
7	7	1	15	1	\$12,443	\$8,479	98	114	0
8	8	2	12	1	\$12,733	\$10,898	98	0	0
9	9	2	15	1	\$15,389	\$7,000	98	115	0
10	10	2	12	1	\$7,484	\$7,030	98	244	0
11	11	2	16	1	\$20,744	\$17,000	97	143	0
12	12	1	8	1	\$30,774	\$20,748	97	26	1
13	13	1	15	1	\$40,278	\$20,599	97	34	1
14	14	2	15	1	\$18,464	\$15,000	97	137	1
15	15	1	12	1	\$38,000	\$29,000	97	66	0
16	16	1	12	1	\$27,000	\$21,748	97	24	0
17	17	1	15	1	\$46,500	\$35,008	97	48	0
18	18	1	16	3	\$53,000	\$40,789	97	70	0
19	19	1	12	1	\$35,790	\$21,844	96	103	0
20	20	2	12	1	\$9,000	\$7,000	96	48	0
21	21	2	16	1	\$17,674	\$11,000	96	17	0
22	22	1	12	1	\$24,890	\$17,000	96	315	0
23	23	2	15	1	\$15,089	\$11,000	96	75	0
24	24	2	12	1	\$24,028	\$15,000	96	124	1
25	25	2	15	1	\$15,893	\$10,848	96	171	1
26	26	1	15	1	\$11,900	\$8,030	96	14	0
27	27	1	15	3	\$49,399	\$34,000	96	96	0
28	28	1	16	1	\$20,000	\$10,000	96	12	0

Data View Variable View

**Suppose the employees or managements want to know whether there has been any significant improvement in**

**the employee's salary since they joined this company. There have been significant improvements in their current salary compared to their baseline salary or the salary they took at the time of joining. So, in this case, we have repeated measure kind of situation where we have an id, and we have two observations for that id. One is for the current salary, and another is for the beginning salary. So for all ids, we have two observations.**

Employee Data.sav [DataSet1] - IBM SPSS Statistics Data Editor

File Edit View Data Transform Analyze Graphs Utilities Extensions Window Help

1: salary 20000

	id	gender	educ	jobcat	salary	salbegin	jobtime	prevexp	minority
1	1	1	15	3	\$35,373	\$20,000	98	144	0
2	2	1	16	1	\$32,000	\$15,887	98	36	0
3	3	2	12	1	\$12,748	\$11,037	98	381	0
4	4	2	8	1	\$15,883	\$8,483	98	190	0
5	5	1	15	1	\$48,000	\$35,908	98	138	0
6	6	1	15	1	\$24,553	\$10,674	98	67	0
7	7	1	15	1	\$12,443	\$8,479	98	114	0
8	8	2	12	1	\$12,733	\$10,898	98	0	0
9	9	2	15	1	\$15,389	\$7,000	98	115	0
10	10	2	12	1	\$7,484	\$7,030	98	244	0
11	11	2	16	1	\$20,744	\$17,000	97	143	0
12	12	1	8	1	\$30,774	\$20,748	97	26	1
13	13	1	15	1	\$40,278	\$20,599	97	34	1
14	14	2	15	1	\$18,464	\$15,000	97	137	1
15	15	1	12	1	\$38,000	\$29,000	97	66	0
16	16	1	12	1	\$27,000	\$21,748	97	24	0
17	17	1	15	1	\$46,500	\$35,008	97	48	0
18	18	1	16	3	\$53,000	\$40,789	97	70	0
19	19	1	12	1	\$35,790	\$21,844	96	103	0
20	20	2	12	1	\$9,000	\$7,000	96	48	0
21	21	2	16	1	\$17,674	\$11,000	96	17	0
22	22	1	12	1	\$24,890	\$17,000	96	315	0
23	23	2	15	1	\$15,089	\$11,000	96	75	0
24	24	2	12	1	\$24,028	\$15,000	96	124	1
25	25	2	15	1	\$15,893	\$10,848	96	171	1
26	26	1	15	1	\$11,900	\$8,030	96	14	0
27	27	1	15	3	\$49,399	\$34,000	96	96	0
28	28	1	10	1	\$20,000	\$10,000	96	42	0

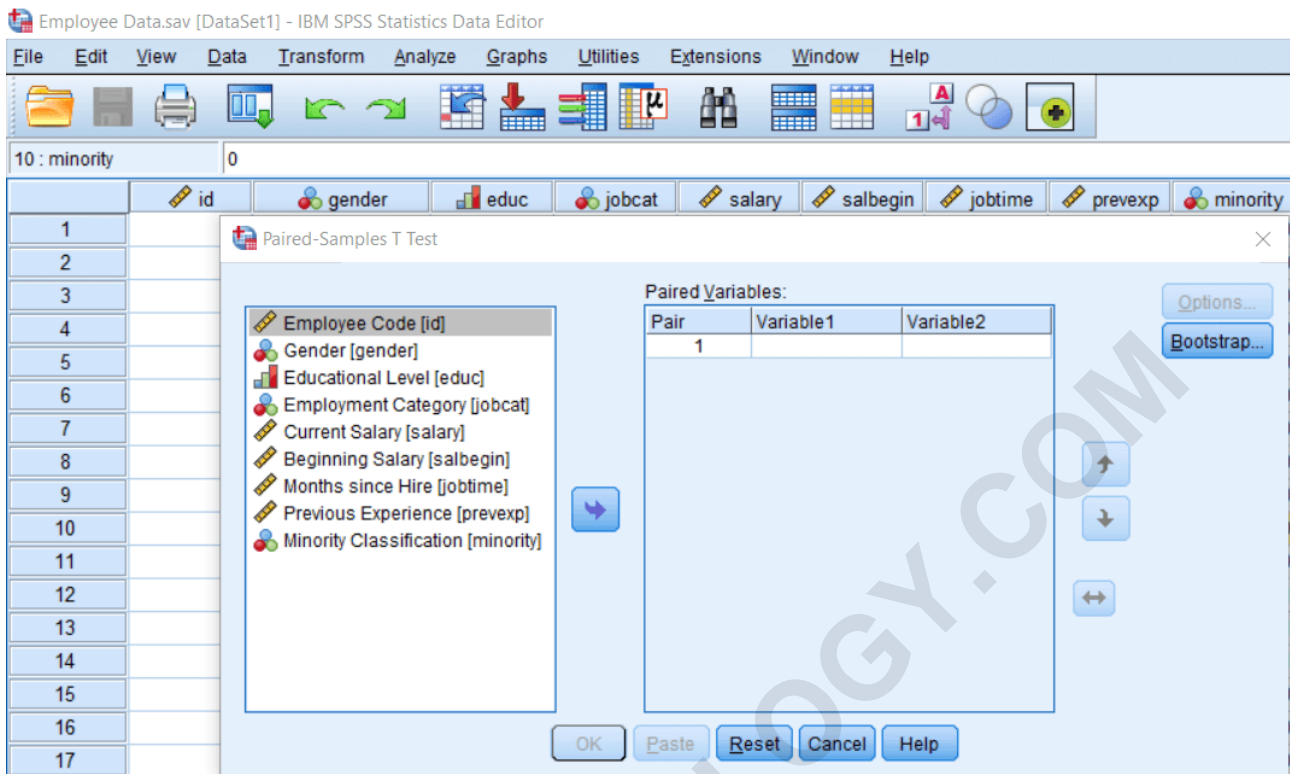
Data View Variable View

To conduct a Paired sample t-test, we will go to the Analyze menu and Compare Means and look at the Paired Sample T-test.

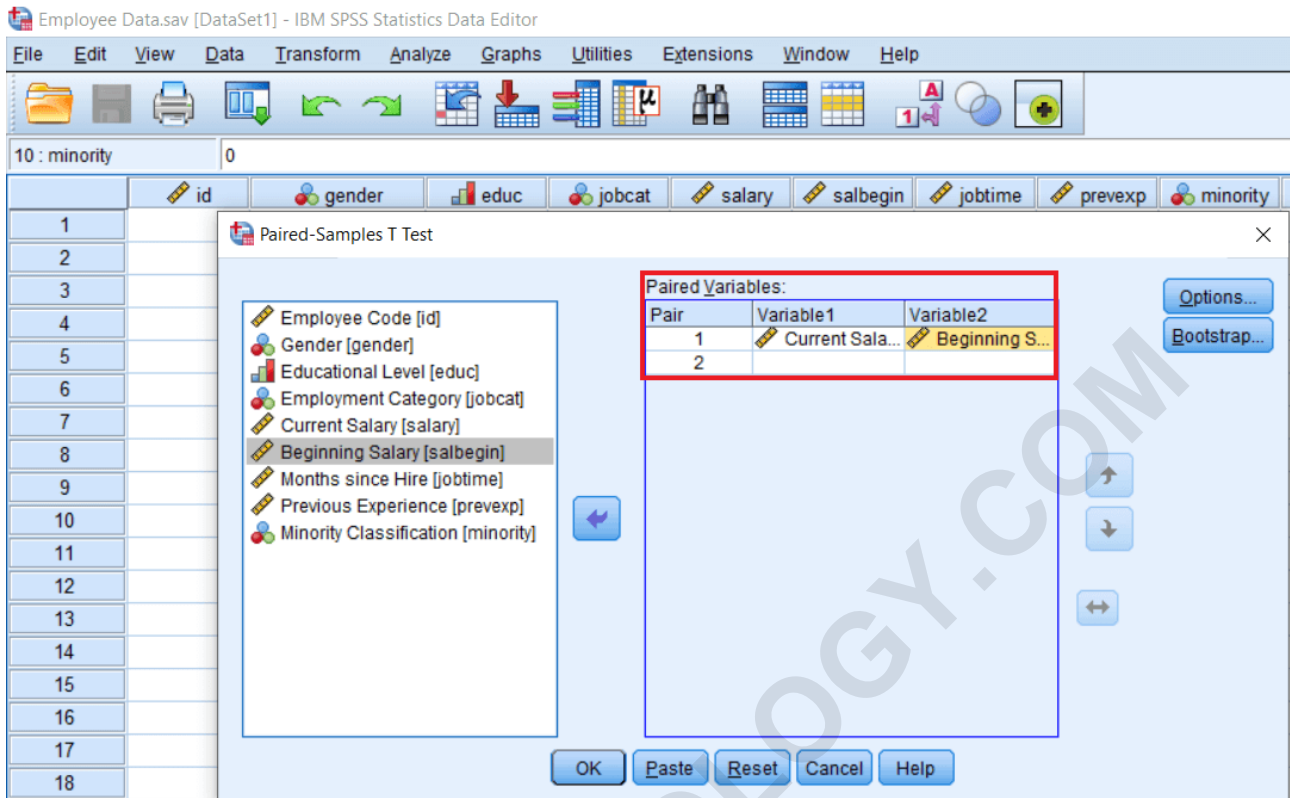
The screenshot shows the IBM SPSS Statistics Data Editor interface. The 'Analyze' menu is open, and the 'Compare Means' option is selected. The submenu for 'Compare Means' is also open, showing several options: 'Means...', 'One-Sample T Test...', 'Independent-Samples T Test...', 'Summary Independent-Samples T Test', 'Paired-Samples T Test...', and 'One-Way ANOVA...'. The 'Paired-Samples T Test...' option is highlighted. The background shows a data table with columns for 'id', 'gender', 'y', 'salbegin', 'jobtime', 'prevexp', and 'minority'.

	id	gender	y	salbegin	jobtime	prevexp	minority
1	1						0
2	2						0
3	3						0
4	4						0
5	5						0
6	6						0
7	7						0
8	8						0
9	9						0
10	10						0
11	11						0
12	12						0
13	13						0
14	14						0
15	15						0
16	16						0
17	17						0
18	18						0
19	19						0
20	20						0
21	21						0
22	22						0
23	23						0
24	24						0
25	25						0

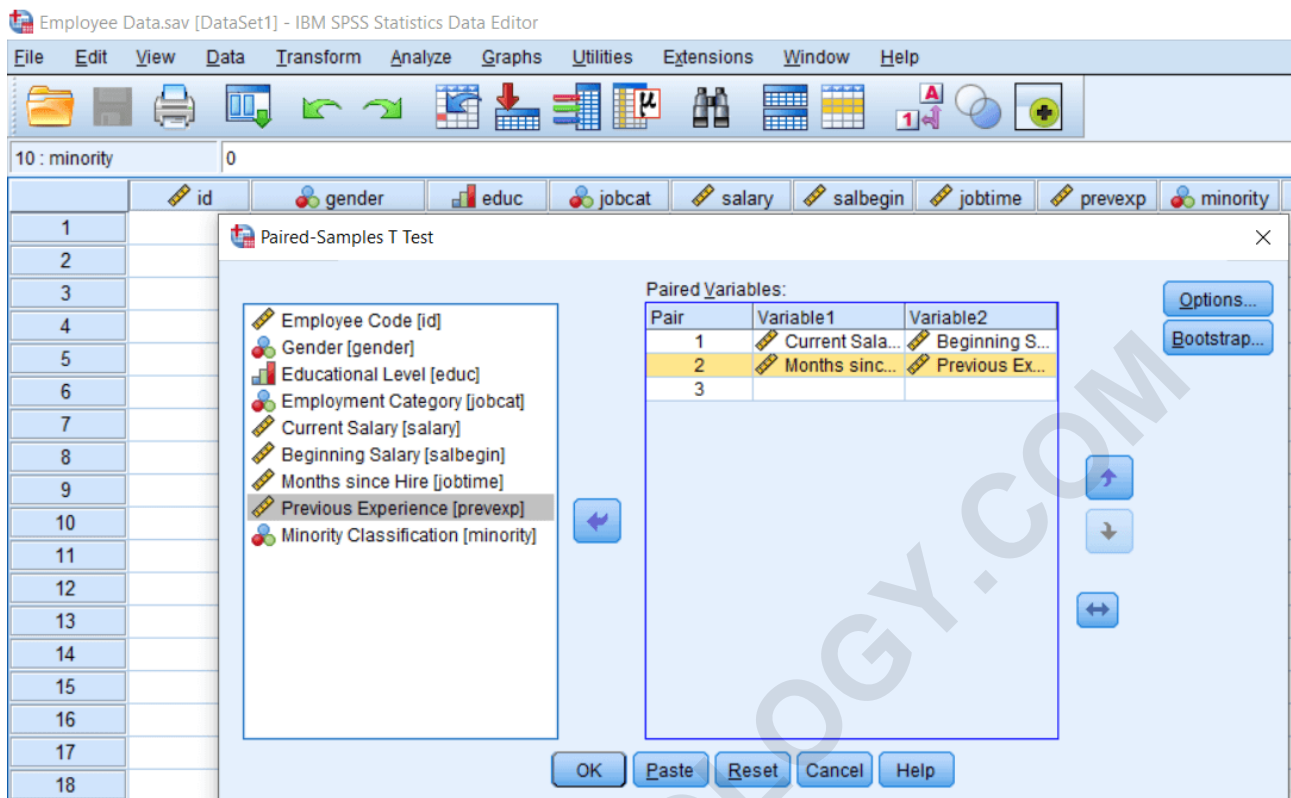
The symbol of Paired sample T-test reads as  $t_{A1-A2}$ . It means the groups A1 and A2 are part of the same group. They are the same individuals just they have been measured in two different situations. If we look at the symbol of the Independent sample t-test, we find  $t_{A-B}$ . It means they are different individuals, as people from Delhi and Mumbai. Now we will select the Paired sample t-test option, and the following dialog box will open:



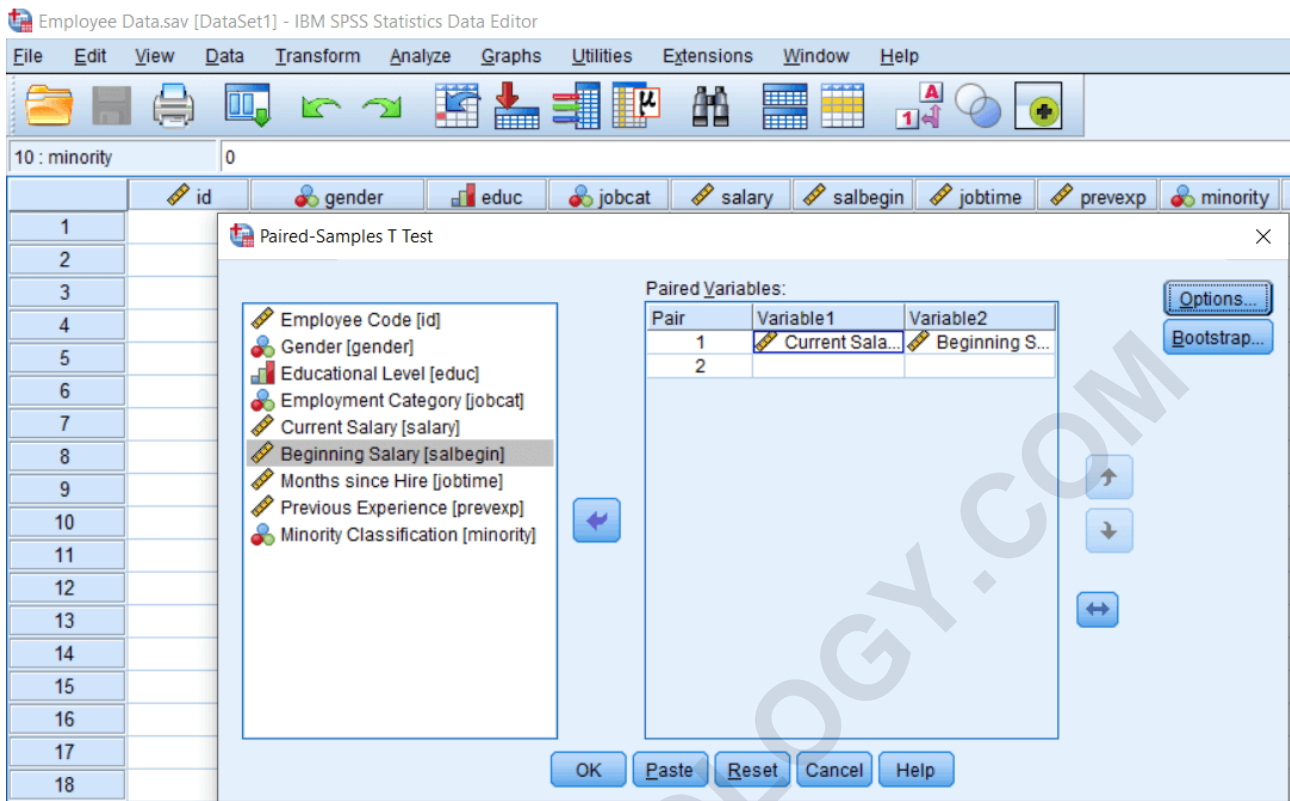
Now we have to define our pairs. So our first pairs are the Current salary of the employees and the Beginning salary of the employees. We will shift the Current salary in Variable 1 and Beginning salary in Variable 2 like this:



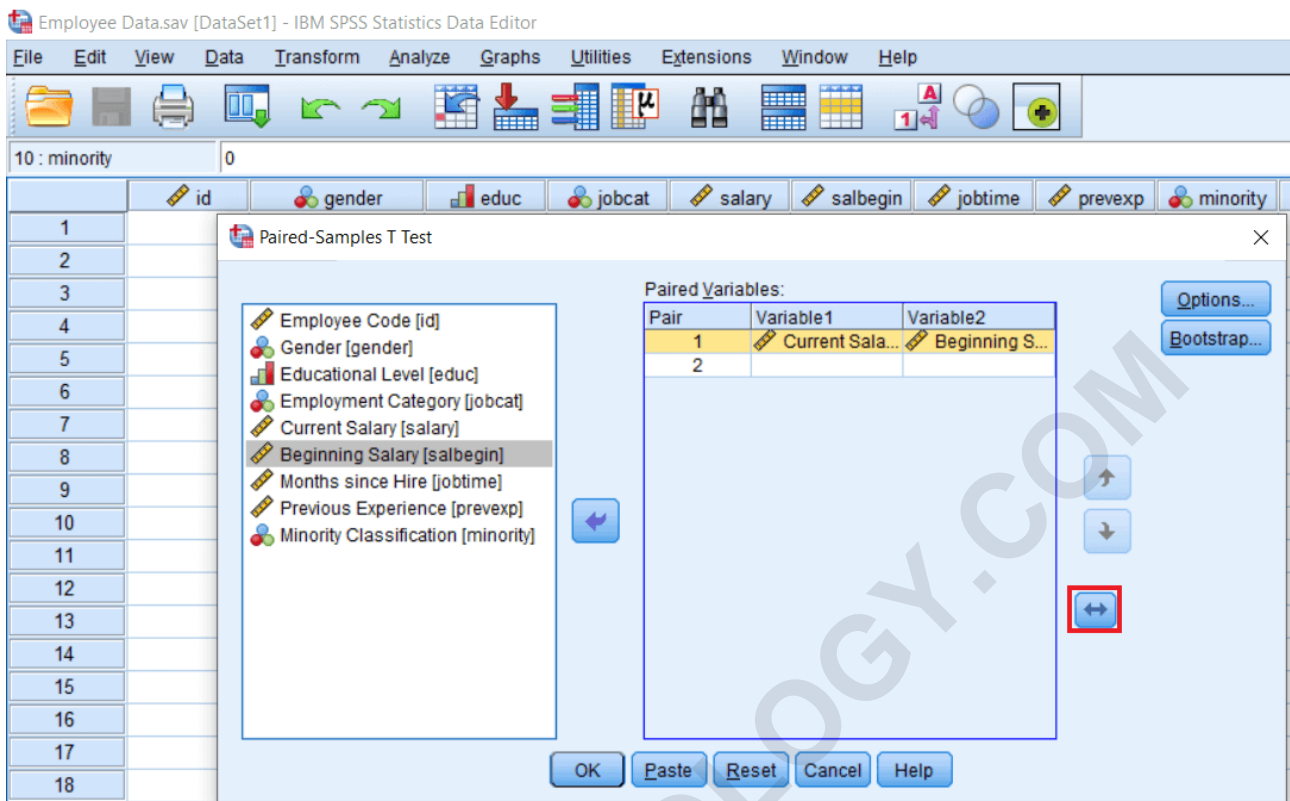
**We are finding the differences between the Current salary and the Beginning salary. So that's our Pair 1. If we have more pairs, we can make multiple pair comparison by defining our pairs in Pair 2. In Pair 2, we are defining joining month in variable 1 and previous experience in variable 2 only for the learning purpose.**



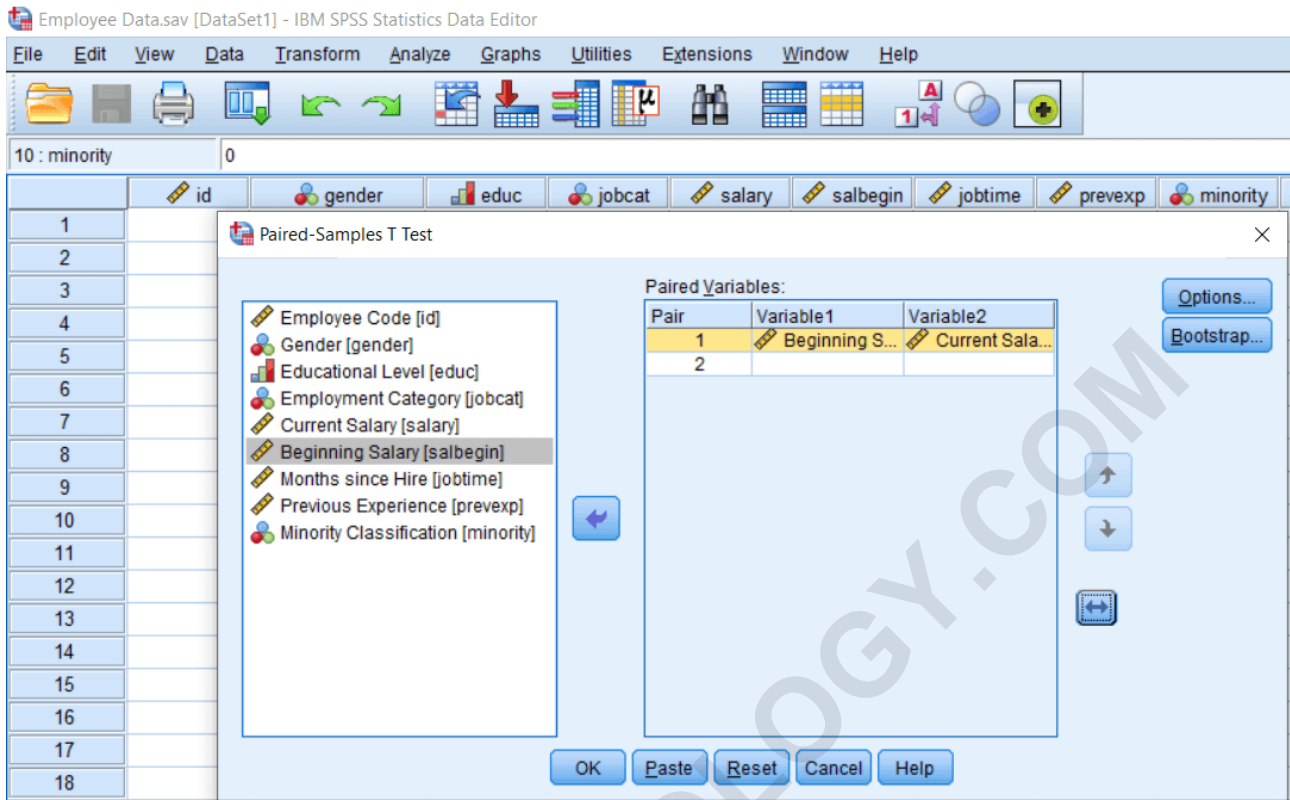
**These are not meaningful Pairs. Once we select pair 2, we can see that pair 3 is automatically activated. Pair 2 is not meaningful, so we are going to remove it. So we are taking just one pair to compare.**



Rests of the Options are the same as the Independent sample t-test. If we want to know more about them, we can look at the Independent sample t-test file. In the above image, an arrow can be used to change the position of our variables. For example, the current salary is our first variable, and beginning salary is our second variable. But if we want to change their position, we can select the pair and click on this arrow tab like this:



**When we click on the arrow tab, we can see the beginning salary as our first variable, and the current salary has become our second variable like this:**



The only difference is going to make in the sign of our data. It's going to give us either a positive value or negative value depending upon the situation. For example, we know that current employees must be drawing more salary than their beginning salary. So if we take the beginning salary as our first variable, we will get a negative test. Remember, the formula of  $t$  is the difference between Group Means divided by Standard Error. So the difference between Group Means is going to a negative value because the beginning salary was lesser than the current salary. We want to avoid the negativity value, so in that case, we can take

our current salary as the first variable. It is not going to have any implication for our result or actual conclusion that we draw. It is only going to change the sign of our t-test value. Now we will click on the Ok button:

