In this example, the T-test for independent samples could help determine whether the last column data outperforms previous columns.

- State the research question:
  - Does the last column outperforms the previous columns?
- State the statistical hypothes.

  $H_0: \mu_1 = \mu_2$

  $H_1: \mu_1 \neq \mu_2$
- Set the decision rule

  $\alpha = 0.05$

  $df = (n_1 - 1) + (n_2 - 1) = 18$

  $t_{0.05} = \cancel{1.734}\ 2.1$
- Calculate the test statistic individually.

(1) Data set DNC: 7 11 15 18 21 25 28 32.5 36 39

Data set QCM: 2 3 4 5 6 7 8.5 10.5 11.5 12.5

1. Sum of the two groups:

DNC: $7+11+15+18+21+25+28+32.5+36+39 = 232.5$

QCM $2+3+4+5+6+7+8.5+10.5+11.5+12.5 = 70$

2. Square the sums from step 1:

DNC: $232.5^2 = 54056.25$

QCM: $70^2 = 4900$

3. Calculate the means for the two groups:

DNC: $(7+11+15+18+21+25+28+32.5+36+39)/10 = 23.25$

QCM: $70/10 = 7$

4. Square the individual ~~scores~~ data and then add them up:

DNC: $7^2+11^2+15^2+18^2+21^2+25^2+28^2+32.5^2+36^2+39^2 = 6442.25$

QCM: $2^2+3^2+4^2+5^2+6^2+7^2+8.5^2+10.5^2+11.5^2+12.5^2 = 610$

5.

$$t = \frac{232.5 - 70}{\sqrt{\frac{6442.25 - \frac{54056.25}{10} + 610 - \frac{4900}{10}}{18} \cdot 0.2}} \approx \frac{162.5}{4.872} \approx 33.35 > 2.1$$

6. ~~reject the null hypothesis~~

Therefore, $P < 0.05$. As the p-value is less than the alpha level, there is a significant difference.

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(2) Data set SLA 5 9 13 15.5 18 21 24 26.5 29 30.5

Data set QCM 2 3 4 5 6 7 8.5 10.5 11.5 12.5

1. Sum of the two groups:

SLA: $5+9+13+15.5+18+21+24+26.5+29+30.5=191.5$

QCM: $2+3+4+5+6+7+8.5+10.5+11.5+12.5=70$

2. Square the sums from Step 1:

SLA. $191.5^2 = 36672.25$

QCM: $70^2 = 4900$

3. Calculate the means for the two groups:

SLA: $191.5/10 = 19.15$

QCM: $70/10 = 7$

4. Square the individual data and then add them up.

SLA: $5^2+9^2+13^2+15.5^2+18^2+21^2+24^2+26.5^2+29^2+30.5^2 = 4329.75$

QCM: $2^2+3^2+4^2+5^2+6^2+7^2+8.5^2+10.5^2+11.5^2+12.5^2 = 610$

5.

$$t = \frac{191.5 - 70}{\sqrt{\left(4329.75 - \frac{36672.25}{10} + 610 - \frac{4900}{10}\right)/18 \times \left(\frac{1}{10}+\frac{1}{10}\right)}}$$

$$\approx \frac{121.5}{2.95}$$

$$= 41.1864721$$

6. reject the hypothesis

Therefore, $p<0.05$. As the p-value is less than the alpha level, there is a significant difference.

(3) Data set Hy-IoT: 4 6 8 10 13 15 18.5 21.6 24 26

Data set QCM: 2 3 4 5 6 7 8.5 10.5 11.5 12.5

1. Hy-IoT. $4+6+8+10+13+15+18.5+21.6+24+26=146.1$

QCM: 70

2. Hy-IoT: $146.1^2 = 21345.21$

QCM: $70^2 = 4900$

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3. Hy-IoT : $146.1/10 = 14.61$

QCM : $70 / 10 = 7$

4. $4^2+6^2+8^2+10^2+13^2+15^2+18.5^2+24.6^2+24^2+26^2 = 2670.81$

610

5.
$$t = \frac{146.1 - 70}{\sqrt{\left(2670.81 - \frac{21345.21}{10} + 610 - \frac{4900}{10}\right)/18 \times \frac{1}{5}}}$$

$$\approx \frac{76.1}{2.7}$$

$$= 28.185 > 2.1$$

6. ∴ reject the null hypothesis.

There $p < 0.05$. As the p-value is less than the alpha level. there is a significant difference.

Overall, we could conclude that the null hypothesis is the opposite of what we assume. This means that the previous data columns are different with the last data column. According to the question, we could find the QCM data is better than other data.