Example 4: While blood type frequencies in the U.S. are in the ratios of 9:8:2:1 for types $O, A, B$, and $A B$, respectively, local differences are often found depending upon a variety of demographic characteristics. A researcher is assigned to determine if patients at a particular large city general hospital exhibit blood types supporting the above model. The table below gives the data results from a random sample of 500 patient lab results.

|  | O | A | B | $A B$ |
| :---: | :---: | :---: | :---: | :---: |
| Researcher | 253 | 194 | 38 | 15 |

Do the data reported by the researcher support the 9:8:2:1 model for blood types of patients at the particular hospital? Justify your answer.

Help from the TI-Nspire:
Select "(enem" $\rightarrow$ "Add Lists \& Spreadsheet"
Name the column "researcher" and enter the data.
Name the second column "ratios" and enter the data.


Name the third column "predicted", in the gray region put the formula:
predicted:= (ratios/sum(ratios))Asum(researcher)

"enter" now results in:

|  | ${ }^{\text {A }}$ researcher | Bratios | ${ }^{\text {C }}$ predicted | D |
| :---: | :---: | :---: | :---: | :---: |
| - |  |  | = ratios/(sum |  |
| 1 | 253 | 9 | 225 |  |
| 2 | 194 | 8 | 200 |  |
| 3 | 38 | 2 | 50 |  |
| 4 | 15 | 1 | 25 |  |
| 5 |  |  |  |  |
| 6 |  |  |  | $\checkmark$ |
|  | C1 1 =225 |  |  |  |

Select "(meny" $\rightarrow$ "Statistics" $\rightarrow$ "Stat Tests" $\rightarrow$ "X2GOF"
For "Observed List" choose "researcher"
For "Expected List" choose "predicted"
For "df" choose " 3 "
Then "ok" results in:

|  | ratios | ${ }^{\text {C predicted }}$ | D | E |
| :---: | :---: | :---: | :---: | :---: |
| - |  | = ratios/(sum |  | $=\chi^{2} \mathrm{GOF}(\mathrm{r} r$ |
| 1 | 9 | 225 | Title | $\mathrm{X}^{2}$ GOF |
| 2 | 8 | 200 | $\mathrm{X}^{2}$ | 10.5444 |
| 3 | 2 | 50 | PVal | 0.014462 |
| 4 | 1 | 25 | df | 3. |
| 5 |  |  | CompLis... | 〔3.48444... |
| 6 |  |  |  | $\square$ |
| E1 1 = " $\chi^{2}$ GOF" |  |  |  |  |

From this TI-Nspire screen we can answer the question.
There are four elements to this solution.
State the hypotheses
$H_{0}$ : the distribution of blood types among patients at this hospital are in the ratios of 9:8:2:1 for types $\mathrm{O}, \mathrm{A}, \mathrm{B}$, and $A B$, respectively.
$H_{\mathrm{a}}$ : the distribution of blood types among patients at this hospital are not in the ratios of 9:8:2:1 for types $\mathrm{O}, \mathrm{A}, \mathrm{B}$, and $A B$, respectively.

Identify the test by name or formula and check the assumptions
Chi-square goodness-of-fit test

$$
\chi^{2}=\sum \frac{(\text { observed }- \text { expected })^{2}}{\text { expected }}
$$

Check assumptions

1. The researcher claims that the data are from a random sample of patient records.
2. From the Nspire, the ratios 9:8:2:1 give expected cell frequencies of $225,200,50$, and 25 each of which is at least 5 .

Correct mechanics:
From the Nspire we have $X^{2}=10.5444, \mathrm{df}=3$, and $P=.014462$
Conclusion in context with linkage to the $P$-value:
With this small a $P$-value (for example, less than $a=.05$ ), there is evidence that the distribution of blood types among patients at this hospital are not in the ratios of 9:8:2:1 for types $O, A, B$, and $A B$, respectively.

