Math 3070 § 1.	**Debate Data:**	Name: Example
Treibergs	**Tabulating Two-Way Tables**	May 19, 2011

In this example, we consider a common data manipulation question, following Elliott's *Learning SAS in the Computer Lab, 2nd. ed.,* Brooks/Cole, 2000 Module 20. This data processing task used to be done fifty years ago by collating machines, the "I. B. M. Machines," that made Big Blue big.

Debate coach Ronda Nielson of Skyline High School wanted to know if Granger, Hunter, Kearns and Skyline differed in the effectiveness of debate classes in teaching valuable life skills, at least according to opinions of debaters. A survey asked debaters to rate how their debate class compares in teaching skills to other classes. They gave the ratings 1 =more effective, 2 =just as effective, 3 =less effective, which were stored in the variable *Compared*. The task of the analyst is to cut the data set down to the four high schools in question and to the variables *School* and *Compared*. The number of responses in each category are counted. Some respondents didn't answer all the questions, so that missing values had to be omitted. Once frequencies are available, the differences in high schools can be tested using the χ^2-test for homogeneity. The high p-value indicates that the high schools were not significantly different in responses to the question comparing debate to other classes.

We further illustrate how to assemble tables that give the frequency, percentages and expected values of cells, and to display them in a way similar to how the SAS frequency procedure arranges output.

Data File Used in this Analysis:

```
# Math 3070 - 1        Debate Data                    May 18, 2011
# Treibergs
#
#  From Elliott, Learning SAS in the Computer Lab, 2nd ed, Brooks/Cole 2000
#
#  Data collected from Granite School District of Utah debate students survey
#  by Ronda Nielson of Skyline HS. Questions were on debate classes.
#
# Variables
#
# Number          Survey number
# School          (1=Cottonwood, 2=Cyprus, 3=Granger, 4=Granite, 5=Hunter, 6=Kearns,
#                 7=Olympus, 8=Skyline, 9=Taylorsville)
# Gender         (1=male 2=female)
# Compared       How debate compares in teaching skills
#                (1=more effective, 2=just as effective, 3=less effective)
# Argumentation  Effectiveness of speech/debate in teaching
#                (1=very effective, 2=somewhat effective,3=not at all effective)
# Research       (same as Argumentation)
# Reasoning      (same as Argumentation)
# Speaking       (same as Argumentation)
Number School Gender Compared Argumentation Research Reasoning Speaking
1   6  1  1   1  1  1   1
108 7  1  1   1  1  1   2
56  3  1  1   1  1  1   1
55  8  1  1   1  2  1   1
54  8  1  1   1  2  1   1
```

53	8	1	1	1	1	1	1
52	8	1	1	1	1	1	1
51	8	1	2	1	1	1	1
50	8	1	1	1	2	1	2
49	8	1	1	1	1	1	1
48	8	1	1	2	2	2	1
47	8	1	1	1	1	1	1
46	9	2	1	1	2	1	1
45	9	2	2	1	2	1	1
44	8	2	2	2	2	1	1
43	8	1	1	1	1	1	1
42	8	1	1	1	1	1	1
41	8	1	1	1	1	1	1
40	8	.	1	1	2	1	1
39	8	1	2	1	2	2	1
38	8	1	1	1	1	1	1
37	8	1	1	1	1	1	1
36	8	1	1	1	1	1	1
35	8	1	1	1	2	2	2
34	8	1	2	1	2	1	1
33	8	1	2	1	2	1	1
299	1	2	1	1	2	1	1
298	1	1	.	1	1	1	1
297	1	1	1	1	1	1	1
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295	1	1	1	1	1	1	1
294	1	2	2	1	1	1	1
293	1	2	1	1	1	1	1
292	1	1	1	1	1	1	1
291	1	2	1	1	1	1	1
290	1	1	1	1	1	1	1
289	1	1	1	1	2	1	1
288	1	2	2	2	2	3	2
287	8	1	1	1	1	1	1
286	1	2	1	1	1	1	1
285	1	1	1	1	1	1	1
284	1	2	.	1	2	2	1
283	1	2	1	1	1	2	1
282	1	1	1	1	1	1	1
281	1	1	2	1	2	1	2
280	1	2	1	1	1	1	1
279	1	1	1	1	1	1	1
317	1	1	1	1	1	1	1
316	1	2	2	1	1	1	1
315	1	1	1	2	2	1	1
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300	1	1	1	1	1	1	1
277	3	1	1	1	1	1	1
278	3	1	1	1	1	1	1
109	7	1	1	1	1	1	1
251	7	1	1	1	.	1	1
252	7	1	1	1	1	1	1

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254	7	1	2	2	1	1	1
255	7	2	1	1	1	1	1
258	7	.	1	1	2	1	1
319	3	1	1	2	1	1	1
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257	7	2	1	1	1	1	1
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260	7	2	.	1	2	1	1
263	7	1	1	1	2	1	1
264	7	1	1	1	1	1	1
265	7	2	1	1	1	1	1
266	7	2	1	1	1	1	1
267	7	1	1	1	1	1	1
268	7	1	1	1	2	1	1
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272	7	2	2	2	1	1	2
273	7	1	1	1	2	1	1
274	7	2	1	1	1	1	1
275	7	2	2	2	2	1	2
276	7	1	2	1	1	2	2
261	7	1	2	1	3	2	1
262	7	1	2	2	2	2	1
229	3	1	1	1	2	1	1
230	3	2	1	1	1	1	1
231	3	1	1	1	1	1	1
232	3	1	1	1	2	1	1
233	9	2	1	1	1	1	2
234	9	1	2	1	1	1	1
235	9	1	1	2	1	1	1
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237	3	1	2	1	1	1	1
238	3	2	2	2	2	2	1
239	3	1	2	1	1	1	1
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242	3	2	1	2	1	1	1
243	3	1	1	1	1	1	1
244	3	1	1	1	1	1	1
245	3	2	1	1	1	1	1
246	3	1	1	1	2	1	1
247	7	1	1	1	1	1	1
248	7	1	1	2	1	1	2
249	7	2	2	1	1	1	1
250	7	1	3	1	3	1	1
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28	2	2	1	1	1	1	1

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24	2	1	1	1	2	1	1
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19	2	2	2	2	3	1	1
18	2	2	1	1	2	1	1
17	2	1	1	1	1	1	1
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224	3	2	1	1	1	1	1
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214	8	2	1	1	1	1	1
217	8	2	1	1	1	1	1
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204	8	1	1	.	.	.	.
203	8	1	1	1	1	2	1

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191	9	2	2	2	2	2	3
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189	9	2	1	1	1	2	1
188	9	1	1	2	2	1	1
187	9	1	1	1	2	1	1
184	7	1	1	1	1	1	1
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174	9	2	1	2	1	2	2
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170	.	1	2	.	.	1	1
169	9	2	2	1	1	1	1
168	9	2	1	1	1	1	1
167	9	1	1	1	2	1	1
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165	9	1	1	2	1	2	1
164	9	1	2	1	2	2	.
163	9	1	1	1	1	1	1
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342	6	2	2	1	2	1	1
341	6	2	1	1	1	1	1
340	.	1	1	1	1	1	1
339	6	2	1	2	2	2	1
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337	6	1	1	1	1	1	1
336	6	1	2	1	2	1	1
335	6	1	1	2	1	1	1
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331	6	2	2	2	1	2	1
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329	6	2	2	1	2	2	2
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326	6	1	1	1	1	1	1
325	6	1	1	1	1	1	1
344	6	1	2	2	2	1	2
324	6	1	1	1	1	1	1
322	6	1	1	1	2	1	1
323	6	2	1	1	2	1	1
160	7	1	1	1	1	1	1
345	6	1	1	1	1	1	1
159	7	1	1	1	1	1	1
158	9	2	1	1	1	1	1
157	9	2	1	1	1	1	1
156	9	1	1	1	1	1	2
155	8	1	1	1	1	1	1
154	8	2	1	1	1	1	1
153	8	1	2	1	1	1	1
152	8	1	1	1	1	1	1
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142	7	1	1	.	.	.	.
151	8	1	1	1	1	2	1
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149	8	1	1	1	1	1	1
148	8	1	2	.	.	.	.
147	8	1	1	1	1	1	1
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145	9	1	1	2	3	2	2
144	9	2	2	2	1	1	3
141	7	1	2	2	1	1	2
140	7	1	1	1	1	1	1
139	7	2	1	1	2	1	2
138	7	1	1	1	1	1	1
137	7	1	2	1	1	1	1
136	7	1	1	1	1	1	1
135	7	1	2	1	2	1	1
134	7	1	2	1	1	1	.
133	.	2	1	1	1	1	1
132	.	1	2	1	1	1	1
131	.	2	1	1	1	1	1
130	9	1	1	1	1	1	1
129	9	2	3	2	1	1	1
128	9	1	2	1	1	1	1
127	9	2	2	1	1	1	1
126	9	1	2	1	1	1	2
125	.	2	2	1	1	1	1
124	7	2	1	2	2	3	2
68	6	1	2	1	1	1	1
67	6	1	1	1	1	1	1

66	6	2	1	1	1	1	1
65	6	1	1	1	1	1	1
64	5	2	1	1	2	1	2
63	.	1	1	1	1	1	1
62	6	1	1	1	1	1	1
61	6	1	1	1	1	1	1
60	6	2	1	1	1	1	1
59	5	1	1	1	1	1	1
58	6	2	1	1	1	1	1
57	6	2	1	1	1	1	1
123	7	2	1	1	1	1	1
122	7	1	1	1	2	1	1
121	7	2	1	1	1	1	1
120	7	2	1	1	1	1	1
119	7	2	1	1	1	1	1
118	7	1	1	1	1	1	1
117	7	1	1	1	2	1	1
116	.	.	1	1	1	1	1
115	7	2	1	1	1	1	.
114	7	2	1	1	1	1	1
113	7	2	1	1	1	.	1
112	7	2	1	1	1	1	1
111	7	2	2	1	1	1	1
110	7	2	1	1	2	1	1
107	7	1	1	1	1	1	1
106	7	2	2	1	1	1	1
105	7	2	1	1	1	1	1
104	8	2	1	1	1	1	1
103	8	2	1	.	.	.	.
102	8	1	1	1	1	1	1
101	8	2	1	1	1	1	1
99	8	2	1	1	1	1	1
98	8	1	1	1	1	1	1
97	7	1	1	1	1	1	1
96	7	1	1	1	1	1	1
95	5	2	1	1	1	1	1
94	5	1	1	1	2	1	1
93	5	2	1	1	1	1	1
92	5	1	1	1	1	1	1
91	5	1	1	1	1	1	1
90	5	2	1	2	1	1	2
89	5	1	1	1	1	1	1
88	5	1	1	2	1	1	1
87	5	1	1	1	1	1	1
86	5	2	1	1	3	1	1
85	5	1	1	1	2	1	1
84	.	1	1	1	2	1	1
83	5	1	1	2	3	2	1
82	5	1	2	2	3	2	2
81	5	2	1	1	1	1	1
80	5	.	1	1	2	1	1
79	5	2	1	1	1	2	1

```
78  5  1  1   2  2  2   2
77  5  1  1   1  1  2   1
76  5  1  1   1  1  1   1
75  6  2  1   1  2  1   1
74  5  1  2   1  2  1   2
73  5  2  2   1  2  1   1
72  5  2  1   1  1  1   1
71  6  1  1   1  1  1   1
70  6  1  1   1  1  1   1
69  6  2  1   1  1  1   1
```

R Session:

```
R version 2.11.1 (2010-05-31)
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ISBN 3-900051-07-0

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  Natural language support but running in an English locale

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'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.

[R.app GUI 1.34 (5589) i386-apple-darwin9.8.0]

> # Read the data file. Note that this file uses the "." for missing data
> # instead of  "NA"  which is standard for R.
> tt <- read.table("M3074DebateData.txt",header=T,na.strings=".")
> tt
    Number School Gender Compared Argumentation Research Reasoning Speaking
1        1      6      1        1             1        1         1        1
2      108      7      1        1             1        1         1        2
3       56      3      1        1             1        1         1        1
4       55      8      1        1             1        2         1        1
5       54      8      1        1             1        2         1        1
6       53      8      1        1             1        1         1        1
7       52      8      1        1             1        1         1        1
8       51      8      1        2             1        1         1        1
9       50      8      1        1             1        2         1        2
10      49      8      1        1             1        1         1        1
11      48      8      1        1             2        2         2        1
12      47      8      1        1             1        1         1        1
13      46      9      2        1             1        2         1        1
14      45      9      2        2             1        2         1        1
```

15	44	8	2	2	2	2	1	1
16	43	8	1	1	1	1	1	1
17	42	8	1	1	1	1	1	1
18	41	8	1	1	1	1	1	1
19	40	8	NA	1	1	2	1	1
20	39	8	1	2	1	2	2	1
21	38	8	1	1	1	1	1	1
22	37	8	1	1	1	1	1	1
23	36	8	1	1	1	1	1	1
24	35	8	1	1	1	2	2	2
25	34	8	1	2	1	2	1	1
26	33	8	1	2	1	2	1	1
27	299	1	2	1	1	2	1	1
28	298	1	1	NA	1	1	1	1
29	297	1	1	1	1	1	1	1
30	296	1	1	1	1	1	1	1
31	295	1	1	1	1	1	1	1
32	294	1	2	2	1	1	1	1
33	293	1	2	1	1	1	1	1
34	292	1	1	1	1	1	1	1
35	291	1	2	1	1	1	1	1
36	290	1	1	1	1	1	1	1
37	289	1	1	1	1	2	1	1
38	288	1	2	2	2	2	3	2
39	287	8	1	1	1	1	1	1
40	286	1	2	1	1	1	1	1
41	285	1	1	1	1	1	1	1
42	284	1	2	NA	1	2	2	1
43	283	1	2	1	1	1	2	1
44	282	1	1	1	1	1	1	1
45	281	1	1	2	1	2	1	2
46	280	1	2	1	1	1	1	1
47	279	1	1	1	1	1	1	1
48	317	1	1	1	1	1	1	1
49	316	1	2	2	1	1	1	1
50	315	1	1	1	2	2	1	1
51	314	1	1	1	1	1	1	1
52	300	1	1	1	1	1	1	1
53	277	3	1	1	1	1	1	1
54	278	3	1	1	1	1	1	1
55	109	7	1	1	1	1	1	1
56	251	7	1	1	1	NA	1	1
57	252	7	1	1	1	1	1	1
58	253	7	2	1	1	2	1	1
59	254	7	1	2	2	1	1	1
60	255	7	2	1	1	1	1	1
61	258	7	NA	1	1	2	1	1
62	319	3	1	1	2	1	1	1
63	256	7	2	2	1	1	1	1
64	257	7	2	1	1	1	1	1
65	259	7	1	1	1	2	1	1
66	260	7	2	NA	1	2	1	1

67	263	7	1	1	1	2	1	1
68	264	7	1	1	1	1	1	1
69	265	7	2	1	1	1	1	1
70	266	7	2	1	1	1	1	1
71	267	7	1	1	1	1	1	1
72	268	7	1	1	1	2	1	1
73	269	7	2	1	1	1	1	1
74	270	7	2	1	1	1	1	1
75	271	7	2	2	2	1	2	1
76	272	7	2	2	2	1	1	2
77	273	7	1	1	1	2	1	1
78	274	7	2	1	1	1	1	1
79	275	7	2	2	2	2	1	2
80	276	7	1	2	1	1	2	2
81	261	7	1	2	1	3	2	1
82	262	7	1	2	2	2	2	1
83	229	3	1	1	1	2	1	1
84	230	3	2	1	1	1	1	1
85	231	3	1	1	1	1	1	1
86	232	3	1	1	1	2	1	1
87	233	9	2	1	1	1	1	2
88	234	9	1	2	1	1	1	1
89	235	9	1	1	2	1	1	1
90	236	9	2	2	3	1	2	2
91	237	3	1	2	1	1	1	1
92	238	3	2	2	2	2	2	1
93	239	3	1	2	1	1	1	1
94	240	3	1	2	1	3	1	1
95	241	3	1	2	1	2	1	1
96	242	3	2	1	2	1	1	1
97	243	3	1	1	1	1	1	1
98	244	3	1	1	1	1	1	1
99	245	3	2	1	1	1	1	1
100	246	3	1	1	1	2	1	1
101	247	7	1	1	1	1	1	1
102	248	7	1	1	2	1	1	2
103	249	7	2	2	1	1	1	1
104	250	7	1	3	1	3	1	1
105	32	7	1	2	2	2	1	1
106	31	2	2	1	1	1	1	1
107	30	2	2	1	2	1	1	1
108	29	2	1	1	1	1	1	1
109	28	2	2	1	1	1	1	1
110	27	2	1	1	1	2	1	1
111	26	2	1	1	1	1	1	1
112	25	2	2	1	1	1	1	1
113	24	2	1	1	1	2	1	1
114	23	2	2	1	1	2	1	1
115	22	2	1	1	1	1	1	1
116	21	2	2	1	1	1	1	1
117	20	2	1	1	2	1	1	2
118	12	2	2	3	1	1	1	1

119	13	2	2	1	1	1	1	1
120	14	2	1	1	1	1	1	1
121	15	2	2	2	1	3	1	2
122	19	2	2	2	2	3	1	1
123	18	2	2	1	1	2	1	1
124	17	2	1	1	1	1	1	1
125	16	2	1	1	1	1	1	1
126	11	2	1	1	1	2	1	1
127	10	2	1	1	1	1	1	1
128	9	2	1	2	1	1	1	1
129	8	2	1	1	1	1	1	1
130	7	2	1	2	1	1	1	1
131	6	2	1	1	1	1	1	1
132	5	2	1	1	1	1	1	1
133	4	2	2	2	1	1	1	1
134	3	4	1	1	1	1	1	1
135	2	5	2	1	1	1	1	1
136	228	3	1	1	1	1	1	1
137	227	3	2	2	2	2	2	1
138	226	NA	NA	2	1	1	1	1
139	225	3	1	1	1	1	1	1
140	224	3	2	1	1	1	1	1
141	223	8	1	1	1	1	1	1
142	222	8	2	1	2	1	1	1
143	221	8	2	1	1	1	1	1
144	220	8	2	1	1	1	1	1
145	219	8	2	1	1	1	1	1
146	218	8	1	1	1	1	1	1
147	215	8	1	1	1	1	1	1
148	214	8	2	1	1	1	1	1
149	217	8	2	1	1	1	1	1
150	216	8	1	1	1	1	1	1
151	213	8	2	1	1	1	1	1
152	212	8	1	1	1	1	1	1
153	211	8	1	1	1	2	1	1
154	210	8	2	1	1	1	1	1
155	209	8	2	1	1	1	1	1
156	208	8	1	1	1	1	1	1
157	207	8	1	1	1	1	1	1
158	206	8	1	1	1	1	1	2
159	205	8	1	NA	1	1	1	1
160	204	8	1	1	NA	NA	NA	NA
161	203	8	1	1	1	1	2	1
162	202	8	2	1	1	2	1	1
163	201	8	1	1	1	1	1	1
164	200	8	2	1	2	2	2	2
165	199	8	2	1	1	2	1	1
166	198	9	2	2	1	1	1	1
167	197	9	1	2	1	1	1	2
168	196	9	2	2	1	1	1	1
169	195	9	1	2	1	2	1	1
170	194	9	2	2	2	1	2	1

171	193	9	1	2	2	2	1	1
172	192	9	1	1	1	1	1	1
173	320	8	1	1	1	1	1	1
174	321	7	2	1	1	1	1	1
175	191	9	2	2	2	2	2	3
176	190	9	2	2	1	2	1	2
177	189	9	2	1	1	1	2	1
178	188	9	1	1	2	2	1	1
179	187	9	1	1	1	2	1	1
180	184	7	1	1	1	1	1	1
181	183	9	1	1	1	1	1	1
182	182	9	2	1	1	2	1	1
183	181	9	1	1	2	NA	2	2
184	180	9	2	1	2	1	2	2
185	179	9	1	1	1	2	1	1
186	178	9	2	1	1	1	1	1
187	177	9	1	1	2	2	1	2
188	176	9	2	1	1	2	1	1
189	175	9	1	1	1	1	1	1
190	174	9	2	1	2	1	2	2
191	173	NA	2	2	2	1	1	1
192	171	9	1	1	1	1	1	1
193	170	NA	1	2	NA	NA	1	1
194	169	9	2	2	1	1	1	1
195	168	9	2	1	1	1	1	1
196	167	9	1	1	1	2	1	1
197	166	3	2	1	1	1	1	1
198	165	9	1	1	2	1	2	1
199	164	9	1	2	1	2	2	NA
200	163	9	1	1	1	1	1	1
201	162	9	1	1	1	1	1	1
202	161	9	2	1	1	1	1	1
203	343	6	1	1	NA	NA	NA	NA
204	342	6	2	2	1	2	1	1
205	341	6	2	1	1	1	1	1
206	340	NA	1	1	1	1	1	1
207	339	6	2	1	2	2	2	1
208	338	6	2	2	2	1	1	1
209	337	6	1	1	1	1	1	1
210	336	6	1	2	1	2	1	1
211	335	6	1	1	2	1	1	1
212	334	6	1	1	1	2	1	1
213	333	6	2	1	1	1	1	1
214	332	6	2	1	NA	NA	NA	NA
215	331	6	2	2	2	1	2	1
216	330	6	1	1	1	1	1	1
217	329	6	2	2	1	2	2	2
218	328	6	2	1	1	2	1	1
219	327	6	1	1	NA	NA	NA	NA
220	326	6	1	1	1	1	1	1
221	325	6	1	1	1	1	1	1
222	344	6	1	2	2	2	1	2

223	324	6	1	1	1	1	1	1
224	322	6	1	1	1	2	1	1
225	323	6	2	1	1	2	1	1
226	160	7	1	1	1	1	1	1
227	345	6	1	1	1	1	1	1
228	159	7	1	1	1	1	1	1
229	158	9	2	1	1	1	1	1
230	157	9	2	1	1	1	1	1
231	156	9	1	1	1	1	1	2
232	155	8	1	1	1	1	1	1
233	154	8	2	1	1	1	1	1
234	153	8	1	2	1	1	1	1
235	152	8	1	1	1	1	1	1
236	143	7	2	1	1	1	1	1
237	142	7	1	1	NA	NA	NA	NA
238	151	8	1	1	1	1	2	1
239	150	8	1	1	1	1	1	1
240	149	8	1	1	1	1	1	1
241	148	8	1	2	NA	NA	NA	NA
242	147	8	1	1	1	1	1	1
243	146	9	2	2	1	1	1	1
244	145	9	1	1	2	3	2	2
245	144	9	2	2	2	1	1	3
246	141	7	1	2	2	1	1	2
247	140	7	1	1	1	1	1	1
248	139	7	2	1	1	2	1	2
249	138	7	1	1	1	1	1	1
250	137	7	1	2	1	1	1	1
251	136	7	1	1	1	1	1	1
252	135	7	1	2	1	2	1	1
253	134	7	1	2	1	1	1	NA
254	133	NA	2	1	1	1	1	1
255	132	NA	1	2	1	1	1	1
256	131	NA	2	1	1	1	1	1
257	130	9	1	1	1	1	1	1
258	129	9	2	3	2	1	1	1
259	128	9	1	2	1	1	1	1
260	127	9	2	2	1	1	1	1
261	126	9	1	2	1	1	1	2
262	125	NA	2	2	1	1	1	1
263	124	7	2	1	2	2	3	2
264	68	6	1	2	1	1	1	1
265	67	6	1	1	1	1	1	1
266	66	6	2	1	1	1	1	1
267	65	6	1	1	1	1	1	1
268	64	5	2	1	1	2	1	2
269	63	NA	1	1	1	1	1	1
270	62	6	1	1	1	1	1	1
271	61	6	1	1	1	1	1	1
272	60	6	2	1	1	1	1	1
273	59	5	1	1	1	1	1	1
274	58	6	2	1	1	1	1	1

275	57	6	2	1	1	1	1	1
276	123	7	2	1	1	1	1	1
277	122	7	1	1	1	2	1	1
278	121	7	2	1	1	1	1	1
279	120	7	2	1	1	1	1	1
280	119	7	2	1	1	1	1	1
281	118	7	1	1	1	1	1	1
282	117	7	1	1	1	2	1	1
283	116	NA	NA	1	1	1	1	1
284	115	7	2	1	1	1	1	NA
285	114	7	2	1	1	1	1	1
286	113	7	2	1	1	1	NA	1
287	112	7	2	1	1	1	1	1
288	111	7	2	2	1	1	1	1
289	110	7	2	1	1	2	1	1
290	107	7	1	1	1	1	1	1
291	106	7	2	2	1	1	1	1
292	105	7	2	1	1	1	1	1
293	104	8	2	1	1	1	1	1
294	103	8	2	1	NA	NA	NA	NA
295	102	8	1	1	1	1	1	1
296	101	8	2	1	1	1	1	1
297	99	8	2	1	1	1	1	1
298	98	8	1	1	1	1	1	1
299	97	7	1	1	1	1	1	1
300	96	7	1	1	1	1	1	1
301	95	5	2	1	1	1	1	1
302	94	5	1	1	1	2	1	1
303	93	5	2	1	1	1	1	1
304	92	5	1	1	1	1	1	1
305	91	5	1	1	1	1	1	1
306	90	5	2	1	2	1	1	2
307	89	5	1	1	1	1	1	1
308	88	5	1	1	2	1	1	1
309	87	5	1	1	1	1	1	1
310	86	5	2	1	1	3	1	1
311	85	5	1	1	1	2	1	1
312	84	NA	1	1	1	2	1	1
313	83	5	1	1	2	3	2	1
314	82	5	1	2	2	3	2	2
315	81	5	2	1	1	1	1	1
316	80	5	NA	1	1	2	1	1
317	79	5	2	1	1	1	2	1
318	78	5	1	1	2	2	2	2
319	77	5	1	1	1	1	2	1
320	76	5	1	1	1	1	1	1
321	75	6	2	1	1	2	1	1
322	74	5	1	2	1	2	1	2
323	73	5	2	2	1	2	1	1
324	72	5	2	1	1	1	1	1
325	71	6	1	1	1	1	1	1
326	70	6	1	1	1	1	1	1

```
327     69      6      2        1             1        1         1        1
> # we can check the variables available.
> names(tt)
[1] "Number"    "School"     "Gender"    "Compared"      "Argumentation"   "Research"
[7]      "Reasoning"     "Speaking"
>
> ############## CUT THE DATA FRAME TO FOUR HIGH SCHOOLS AND NO NA'S ###############
> # We use the subsetting command. The logical condition includes the desired HS and
> # excludes NA's. select= picks the two desired columns "School" and "Compared".
>
> tt2 <- subset(tt,(School==3 | School==5 | School==6 | School==8 ) &
+ !(is.na(School) | is.na(Compared)),select=c(2,4))
> tt2
    School Compared
1        6        1
3        3        1
4        8        1
5        8        1
6        8        1
7        8        1
8        8        2
9        8        1
10       8        1
11       8        1
12       8        1
15       8        2
16       8        1
17       8        1
18       8        1
19       8        1
20       8        2
21       8        1
22       8        1
23       8        1
24       8        1
25       8        2
26       8        2
39       8        1
53       3        1
54       3        1
62       3        1
83       3        1
84       3        1
85       3        1
86       3        1
91       3        2
92       3        2
93       3        2
94       3        2
95       3        2
96       3        1
97       3        1
```

98	3	1
99	3	1
100	3	1
135	5	1
136	3	1
137	3	2
139	3	1
140	3	1
141	8	1
142	8	1
143	8	1
144	8	1
145	8	1
146	8	1
147	8	1
148	8	1
149	8	1
150	8	1
151	8	1
152	8	1
153	8	1
154	8	1
155	8	1
156	8	1
157	8	1
158	8	1
160	8	1
161	8	1
162	8	1
163	8	1
164	8	1
165	8	1
173	8	1
197	3	1
203	6	1
204	6	2
205	6	1
207	6	1
208	6	2
209	6	1
210	6	2
211	6	1
212	6	1
213	6	1
214	6	1
215	6	2
216	6	1
217	6	2
218	6	1
219	6	1
220	6	1
221	6	1

222	6	2
223	6	1
224	6	1
225	6	1
227	6	1
232	8	1
233	8	1
234	8	2
235	8	1
238	8	1
239	8	1
240	8	1
241	8	2
242	8	1
264	6	2
265	6	1
266	6	1
267	6	1
268	5	1
270	6	1
271	6	1
272	6	1
273	5	1
274	6	1
275	6	1
293	8	1
294	8	1
295	8	1
296	8	1
297	8	1
298	8	1
301	5	1
302	5	1
303	5	1
304	5	1
305	5	1
306	5	1
307	5	1
308	5	1
309	5	1
310	5	1
311	5	1
313	5	1
314	5	2
315	5	1
316	5	1
317	5	1
318	5	1
319	5	1
320	5	1
321	6	1
322	5	2

```
323      5        2
324      5        1
325      6        1
326      6        1
327      6        1
>
> # Now make the subset available locally.
> attach(tt2)
>
> ############################## DO THE CELL COUNTS ##############################
>
> tb1 <- table(tt2) ; tb1
      Compared
School  1  2
     3 17  6
     5 22  3
     6 30  7
     8 55  7
>
> # ROW TOTALS AND COLUMN TOTALS
>
> rowsum <- margin.table(tb1,1); rowsum
School
 3  5  6  8
23 25 37 62
> colsum <- margin.table(tb1,2); colsum
Compared
  1   2
124  23
>
> # To add row and column sums to the table we can column-bind the vector of
> # rowsums, sum the columns and row-bind it to the table.
>
> tb2 <- cbind(tb1,rowsum);tb2
   1 2 rowsum
3 17 6     23
5 22 3     25
6 30 7     37
8 55 7     62

> columnsum <- margin.table(tb2,2)
> rbind(tb2,columnsum)
           1  2 rowsum
3         17  6     23
5         22  3     25
6         30  7     37
8         55  7     62
columnsum 124 23    147
```

```
> ######################### EXPECTED VALUE AND PERCENTAGES OF CELLS ##################
>
> # Let total = sum of all celle = number of valid observations.
> # If p[i] = sum row i / total and q[j] = sum col j / total  are the
> # row and column percentages then the expected number in the [i,j] cell is
> # ex[i,j] = p[i] * q[j] * total = row[i] sum * col[j] sum / total.
>
> # A %o% B is "outer product" is the matrix whose [i,j] entry is A[i]B[j].
> # It gives expected * total.
>
> ex <- ( rowsum %o% colsum )/ sum(tb1) ; ex
      Compared
School        1        2
     3 19.40136 3.598639
     5 21.08844 3.911565
     6 31.21088 5.789116
     8 52.29932 9.700680
>
> # Compute what the cell is as a percent of the whole table.
>
> pct <- 100* tb1 / sum(tb1) ; pct
      Compared
School         1         2
     3 11.564626  4.081633
     5 14.965986  2.040816
     6 20.408163  4.761905
     8 37.414966  4.761905
>
> # Compute what the cell is as a percent of its row.
>
> rowpct <- 100* prop.table(tb1,1) ; rowpct
      Compared
School        1        2
     3 73.91304 26.08696
     5 88.00000 12.00000
     6 81.08108 18.91892
     8 88.70968 11.29032
>
> # Compute what the cell is as a percent of its column.
>
> colpct <- 100* prop.table(tb1,2) ; colpct
      Compared
School        1        2
     3 13.70968 26.08696
     5 17.74194 13.04348
     6 24.19355 30.43478
     8 44.35484 30.43478
```

```
>################### MAKE A SAS STYLE TABLE INCLUDING EX AND PCTS ####################
>
> # One learns that anything is possible in R. The student just has to be tough enough
> # to figure things out by themselves. There are several ways to so this.
> # I concluded that it is easiest just to make a data frame with the numbers (val)
> # viewed as a single vector and with School, Compared and vv (the statistic) as
> # factors. I'm sure one of you will show me an easier way!
>
> compared <- factor(rep(rep(1:2,c(4,4)),5)); compared
 [1] 1 1 1 1 2 2 2 2 1 1 1 1 2 2 2 2 1 1 1 1 2 2 2 2 1 1 1 1 2 2 2 2 1 1 1 1 2 2 2 2
Levels: 1 2
>
> school <- factor(rep(c(3,5,6,8),10)); school
 [1] 3 5 6 8 3 5 6 8 3 5 6 8 3 5 6 8 3 5 6 8 3 5 6 8 3 5 6 8 3 5 6 8 3 5 6 8 3 5 6 8
Levels: 3 5 6 8
>
> vv <- factor(rep(1:5,rep(8,5))) ; vv
 [1] 1 1 1 1 1 1 1 1 2 2 2 2 2 2 2 2 3 3 3 3 3 3 3 3 4 4 4 4 4 4 4 4 5 5 5 5 5 5 5 5
Levels: 1 2 3 4 5
>
> val <-c(tb1,ex,pct,rowpct,colpct) ; val
 [1] 17.000000 22.000000 30.000000 55.000000  6.000000  3.000000  7.000000  7.000000
 [9] 19.401361 21.088435 31.210884 52.299320  3.598639  3.911565  5.789116  9.700680
[17] 11.564626 14.965986 20.408163 37.414966  4.081633  2.040816  4.761905  4.761905
[25] 73.913043 88.000000 81.081081 88.709677 26.086957 12.000000 18.918919 11.290323
[33] 13.709677 17.741935 24.193548 44.354839 26.086957 13.043478 30.434783 30.434783
> sast <- data.frame(school,compared,vv,val); sast
   school compared vv       val
1       3        1  1 17.000000
2       5        1  1 22.000000
3       6        1  1 30.000000
4       8        1  1 55.000000
5       3        2  1  6.000000
6       5        2  1  3.000000
7       6        2  1  7.000000
8       8        2  1  7.000000
9       3        1  2 19.401361
10      5        1  2 21.088435
11      6        1  2 31.210884
12      8        1  2 52.299320
13      3        2  2  3.598639
14      5        2  2  3.911565
15      6        2  2  5.789116
16      8        2  2  9.700680
17      3        1  3 11.564626
18      5        1  3 14.965986
19      6        1  3 20.408163
20      8        1  3 37.414966
21      3        2  3  4.081633
22      5        2  3  2.040816
23      6        2  3  4.761905
24      8        2  3  4.761905
```

25	3	1	4	73.913043
26	5	1	4	88.000000
27	6	1	4	81.081081
28	8	1	4	88.709677
29	3	2	4	26.086957
30	5	2	4	12.000000
31	6	2	4	18.918919
32	8	2	4	11.290323
33	3	1	5	13.709677
34	5	1	5	17.741935
35	6	1	5	24.193548
36	8	1	5	44.354839
37	3	2	5	26.086957
38	5	2	5	13.043478
39	6	2	5	30.434783
40	8	2	5	30.434783

```
> # Give meaningful names to the statisics, the levels of factor vv.
> levels(vv) <- c("Frequency","Expected","Percent","Row Pct","Col Pct")
>
> xtabs(val ~ vv  + compared + school)
, , school = 3

           compared
vv                  1         2
  Frequency 17.000000  6.000000
  Expected  19.401361  3.598639
  Percent   11.564626  4.081633
  Row Pct   73.913043 26.086957
  Col Pct   13.709677 26.086957

, , school = 5

           compared
vv                  1         2
  Frequency 22.000000  3.000000
  Expected  21.088435  3.911565
  Percent   14.965986  2.040816
  Row Pct   88.000000 12.000000
  Col Pct   17.741935 13.043478

, , school = 6

           compared
vv                  1         2
  Frequency 30.000000  7.000000
  Expected  31.210884  5.789116
  Percent   20.408163  4.761905
  Row Pct   81.081081 18.918919
  Col Pct   24.193548 30.434783

, , school = 8

           compared
vv                  1         2
  Frequency 55.000000  7.000000
  Expected  52.299320  9.700680
  Percent   37.414966  4.761905
  Row Pct   88.709677 11.290323
  Col Pct   44.354839 30.434783
```

```
>########################## CHI-SQUARED TEST FOR HOMOGENEITY #################
>
> tb1
      Compared
School  1  2
     3 17  6
     5 22  3
     6 30  7
     8 55  7
>
>
> chisq.test(tb1)

Pearson's Chi-squared test

data:  tb1
X-squared = 3.3431, df = 3, p-value = 0.3417

Warning message:
In chisq.test(tb1) : Chi-squared approximation may be incorrect
>
```