Figure 2.5. DATA ANALYSIS: Ambiguities in Measurements

A common form of assessment in academic subjects, and in some other test situations, is by means of *marks*. Three forms of the same basic data for 12 students in 8 subjects are given below to illustrate matters of interest. Eleven entries in the last column of each table have been omitted for the reader to fill in by adding the relevant eight numbers for each student; check your arithmetic by calculating the average, range and s.d. of your first two totals.

MARKS

	Art	Biol.	Chem.	Drama	Eng.	French	Geog.	Hist.	Total
Ann	100	72	47	75	40	30	30	47	
Bob	90	60	70	65	20	48	38	43	
Clair	61	45	80	55	41	62	36	40	
Don	63	90	35	70	30	47	32	51	
Elise	54	82	41	40	45	49	55	41	
Frank	80	63	20	45	65	38	45	49	**405**
Gail	23	55	60	80	60	32	47	45	
Henry	40	70	65	20	56	60	35	52	
Iris	85	40	30	51	28	55	40	60	
Jim	72	10	75	35	25	66	54	50	
Kate	48	34	10	60	70	36	57	55	
Len	10	20	58	30	35	70	60	59	
Average	*60*	*53*	*49*	*52*	*43*	*49*	*44*	*49*	*401*
Range	*90*	*80*	*70*	*60*	*50*	*40*	*30*	*20*	*99*
S.d.	*27*	*24*	*22*	*19*	*17*	*13*	*10*	*7*	*27*

SCALED MARKS

	Art	Biol.	Chem.	Drama	Eng.	French	Geog.	Hist.	Total
Ann	100	77	53	92	40	0	0	35	
Bob	89	63	86	75	0	45	27	15	
Clair	57	44	100	58	42	80	20	0	
Don	59	100	36	83	20	43	7	55	
Elise	51	90	44	33	50	48	83	5	
Frank	78	66	14	42	90	20	50	45	**405**
Gail	14	56	71	100	80	5	57	25	
Henry	33	75	79	0	72	75	17	60	
Iris	83	38	29	52	16	62	34	100	
Jim	69	0	93	25	10	90	80	50	
Kate	42	30	0	67	100	15	90	75	
Len	0	12	69	17	30	100	100	95	
Average	*56*	*54*	*56*	*54*	*46*	*49*	*47*	*47*	*408*
Range	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*100*	*26*
S.d.	*30*	*30*	*32*	*31*	*33*	*34*	*35*	*33*	*8*

RANKS

	Art	Biol.	Chem.	Drama	Eng.	French	Geog.	Hist.	Total
Ann	1	3	7	2	7	12	12	8	
Bob	2	6	3	4	12	7	8	10	
Clair	7	8	1	6	6	3	9	12	
Don	6	1	9	3	9	8	11	5	
Elise	8	2	8	9	5	6	3	11	
Frank	4	5	11	8	2	9	6	7	**52**
Gail	11	7	5	1	3	11	5	9	
Henry	10	4	4	12	4	4	10	4	
Iris	3	9	10	7	10	5	7	1	
Jim	5	12	2	10	11	2	4	6	
Kate	9	10	12	5	1	10	2	3	
Len	12	11	6	11	8	1	1	2	

(*continued overleaf*)

1 If the Question requires ranking the students based on the three versions of their marks, what Answers would you give?
- How do you account for your three *different* Answers?

2 Suggest an *actual* situation to which the ambiguity illustrated by these data is relevant.
- Could the ambiguity be reduced or eliminated in the situation you describe? Explain briefly.

3 Describe briefly what the data given overleaf on page 2.13 indicate about the relationships among:
- the *averages* of the 8 courses and the average of the totals;
- the *ranges* of the 8 courses and the range of the totals;
- the *s.d.*s of the 8 courses and the s.d. of the totals;
- the *ranges* and *s.d.*s of the 8 courses and the totals.

What are the implications of these relationships for the use of averages, ranges and s.d.s as numerical data summaries?

REFERENCE: Wilson, Bryan: *The First shall be Last*; in *The Best of Teaching Statistics* (ed. Peter Holmes), Teaching Statistics Trust, Department of Probability and Statistics, University of Sheffield, 1986, pp. 167-169.

The data given overleaf on page 2.13 have been slightly adapted from those in this source.