

Figure 3.6c. STEM PLOTS: Midterm Marks

STAT 230

MIDTERM MARKS – Fall Term, 1989

| SUMMARY: | Tutorial Section(s) | Average (Average and median out of 50) | S.d. | Median | IQR | n | Number passing |
|----------|---------------------|---|------|--------|-----|-----|----------------|
| | All | 21.1 | 7.3 | 20 | 9 | 238 | 64 |
| | Section 05 | 21.8 | 6.6 | 21 | 8½ | 61 | 20 |
| | Section 06 | 21.0 | 8.4 | 20 | 9 | 61 | 19 |
| | Section 07 | 20.6 | 7.2 | 20 | 8 | 60 | 13 |
| | Section 08 | 20.9 | 7.0 | 20 | 7½ | 56 | 12 |

Distribution of marks (stemplot):

| | |
|--|------|
| 4 56 | (2) |
| 4 334 | (3) |
| 3 5789 | (4) |
| 3 00001 11222 33334 444 | (18) |
| 2 55555 55555 55666 66666 67777 77788 88899 99 | (37) |
| <hr/> | |
| 2 00000 00000 00000 00000 00111 11111 11111 12222 22222 22222 23333 33333 33444 44444 44 | (72) |
| 1 55555 55555 55666 66666 66666 67777 77777 77778 88888 88888 89999 99999 99999 99 | (67) |
| 1 00111 11222 22223 33333 33444 4 | (26) |
| 0 55677 899 | (8) |
| 0 0 | (1) |

Tutorial Section 05: Monday

| | |
|--------------------|-------------------|
| Number of students | 61 |
| Average | 21.8 (44%) |
| S.d. | 6.6 (13%) |
| Median | 21 (42%) |
| IQR | 8.5 (17%) |
| Pass | (20 students) 33% |
| Fail | (41 students) 67% |

Distribution of marks (stemplot):

| | |
|---------------------------|------|
| 4 6 | (1) |
| 4 | (-) |
| 3 | (-) |
| 3 23334 | (5) |
| 2 55556 66667 7788 | (14) |
| <hr/> | |
| 2 00000 00011 12223 33444 | (20) |
| 1 55566 77788 8999 | (14) |
| 1 22334 4 | (6) |
| 0 7 | (1) |
| 0 | (-) |

Tutorial Section 06: Tuesday

| | |
|--------------------|-------------------|
| Number of students | 61 |
| Average | 21.0 (42%) |
| S.d. | 8.4 (17%) |
| Median | 20 (40%) |
| IQR | 9 (18%) |
| Pass | (19 students) 31% |
| Fail | (42 students) 69% |

Distribution of marks (stemplot):

| | |
|-------------------------|------|
| 4 | (-) |
| 4 34 | (2) |
| 3 | (-) |
| 3 00112 234 | (8) |
| 2 55555 6899 | (9) |
| <hr/> | |
| 2 00001 11122 33344 | (15) |
| 1 55556 66667 78899 999 | (18) |
| 1 223 | (3) |
| 0 55899 | (5) |
| 0 0 | (1) |

Tutorial Section 07: Wednesday

| | |
|--------------------|-------------------|
| Number of students | 60 |
| Average | 20.6 (41%) |
| S.d. | 7.2 (14%) |
| Median | 20 (40%) |
| IQR | 8 (16%) |
| Pass | (13 students) 22% |
| Fail | (47 students) 78% |

Distribution of marks (stemplot):

| | |
|---------------------------|------|
| 4 5 | (1) |
| 4 | (-) |
| 3 79 | (2) |
| 3 04 | (2) |
| 2 55566 789 | (8) |
| <hr/> | |
| 2 00000 11112 22223 33444 | (20) |
| 1 55666 77888 88999 9 | (16) |
| 1 01123 3344 | (9) |
| 0 67 | (2) |
| 0 | (-) |

Tutorial Section 08: Wednesday

| | |
|--------------------|-------------------|
| Number of students | 56 |
| Average | 20.9 (42%) |
| S.d. | 7.0 (14%) |
| Median | 20 (40%) |
| IQR | 7.5 (15%) |
| Pass | (12 students) 21% |
| Fail | (44 students) 79% |

Distribution of marks (stemplot):

| | |
|--------------------------|------|
| 4 | (-) |
| 4 3 | (1) |
| 3 58 | (2) |
| 3 014 | (3) |
| 2 67778 9 | (6) |
| <hr/> | |
| 2 00000 11122 22233 44 | (17) |
| 1 55566 66777 77788 9999 | (19) |
| 1 01112 233 | (8) |
| 0 | (-) |
| 0 | (-) |

Background: In 1989, STAT 230 was a probability course that was part of the 10-course core for the 4-year Bachelor of Mathematics degree at the University of Waterloo; it was usually taken by students in their 2A term. In the Fall of 1989, the course was taught for the first time in large lecture sections, as follows:

- 10.30 a.m. Monday, Wednesday, Friday 50-minute classes held in room DC 1351, with about 240 students registered; this class was split into four 50-minute tutorials held at 4.30 p.m. on Monday, Tuesday, Wednesday and Wednesday, each with about 60 students registered, who were allocated to one of the four time slots by computer scheduling on the basis of the fit to their timetable and, when this criterion was satisfied, on the basis of making the four tutorial sizes as close to equal as possible. The midterm mark data overleaf on page 3.17 are for these students.
 - The timetabling criterion for assigning students to tutorials makes the assignment program-dependent; because different programs may attract students of differing abilities, tutorial assignment is likely *not* equiprobable by ability/motivation.
- 2.30 p.m. Monday, Wednesday, Friday classes held in room BI 271, with about 180 students enrolled; this class was similarly split into four tutorials, held at 3.30 p.m. on Monday, Tuesday, Tuesday and Wednesday, each with about 45 students registered.
- a St. Jerome's section of about 50 students, with classes held from 1.30 p.m. to 3.50 p.m. on Monday and Wednesday; the *one* tutorial for this section of the course was held at 3.30 p.m. (sometimes nearer to 3.15 p.m.) on Wednesday.

Other information about the course organization is as follows:

- There were ten assignments in STAT 230, each consisting of 10-15 problems; five problems per assignment were specified as the *minimum* amount of work needed in the course. Because of constraints on the amount of T.A. time available for assignment grading, only two of the five specified problems per assignment were actually collected (at the Friday class of each week an assignment was due). The term's assignment marks counted towards either 10% or 5% (whichever was more favourable) of each student's final grade in the course.
- Tutorials offered two services to students in STAT 230:
 - the opportunity to attempt to solve, and then to discuss the solution of, three problems different from those on the assignments but also related to the class material of the previous week;
 - assistance with assignment problems. (There were also a number of posted office hours each week with T.A.s for the same purpose.)
- Tutorial attendance for the 10.30 a.m. class was seldom above one-third of the students registered and was often lower; the Monday tutorial (Section 05) consistently showed the highest attendance, Tuesday (Section 06) the the lowest. Tutorial attendance was generally noticeably *higher* for the 2.30 p.m. class than for the 10.30 a.m. class.
 - *Informal* observation suggested 30-40% of students attending Mondays' tutorials, less than 20% attending on Tuesdays, and 20-30% on Wednesdays. Timetabling and commitments in other courses may be a factor here.
- The midterm counted for either 20% or 10% (whichever was more favourable) of each student's final grade. The midterm was held from 5 p.m. to 7 p.m. on the Thursday of the eighth week of term; it was the *last* of the core-course midterms, coming after the corresponding algebra test on the previous Tuesday.

① Using, where appropriate, the background information given above, what answers can you obtain from the data presentations overleaf on page 3.17 to questions about:

- the overall performance of the students on the examination;
- differences in performance among the four tutorial Sections, given that *all* students attended the *same* lectures;
 - how do you account for any difference(s) you observe?
- the difficulty of the midterm examination?

Briefly explain your reasoning in each case.

② To answer the questions posed in 1 above, what *additional* background information would you like to have available? Indicate briefly how each piece of information you want would contribute to your ability to answer the relevant question(s).

③ Because of the financial constraints faced by the University of Waterloo in 1989, it was clearly desirable that resources be used as efficiently as possible – for example, in the area of undergraduate teaching. In this context, outline a *realistic* Plan for investigating the following questions:

- whether a course with about 500 students (*e.g.*, STAT 230) should be taught in two lecture sections of around 250 students each, or in four sections of about 125 students, or in eight sections of around 60 students;
- whether student assignment solutions should be collected for grading, or whether the instructor and T.A. time saved by reducing the number of problems to be submitted, or by *eliminating* assignment submission completely, would be better used in more direct interaction, *outside* classes, of instructors and T.A.s with students;
 - What issue(s), *other than* efficiency, are involved in the matter of whether student assignment solutions should be collected for grading?
- how sensitive student *performance* in a course is to the 'quality' of the instruction in lectures;
- how sensitive student *learning* in a course is to the 'quality' of the instruction in lectures.