# Analysis of Discourse Practices in Statistical Computing Laboratory

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## Abstract

Classroom talk plays a significant role in a teaching and learning process. The author of this paper was concerned with the way student-student and teacher-student discourses promotes students' statistical thinking in the computing laboratory. An observation study was thus conducted to examine how social interactions among students in small groups and the teacher's intervention were organised in the laboratory. In the observation study, verbal speech and peer interaction were audiotaped. The various discourses were transcribed in full, with relevant excerpts being selected for analysis within a Vygotskian framework. The student-student discourse was analysed with the aid of Kumpulainen's framework. It was found that the high use of the organizational, judgmental as well as external thinking functions in the student talk when presenting the chart title and axis labels; approving or disapproving group mate's work; and monitoring data entry actively during keyboard input respectively.

The teacher-student discourse was analysed with the aid of Tharp and Gallimore's framework. Questioning was used frequently by the teacher to discover what the students knew, understood, or misunderstood, and to offer direction towards deeper thinking at times when students could not otherwise make progress on tasks. The teacher also used modelling assistance to help students see how to assemble and organise pieces of knowledge they might have already grasped or possessed. Contingency management was another form of assistance exhibited in the form of praise that affirmed the quality of students' work. The teacher offered cognitive structuring that assisted them to organise and justify various aspects of a regression modelling problem but left room for students to regulate their strategies based on their own creation and interpretation of a regression model they found was the best.

**Key Words:** social interaction, modelling, questioning, cognitive structuring

## Introduction

Information Technology (IT) may re-organise an environment in which students and teachers develop learning partnerships to socially construct knowledge through peer collaboration, classroom talk and social interaction (Jones & Mercer, 1993; Mercer, 1995). Classroom talk plays a significant role in a teaching and learning process (Goos, 2000) because students construct knowledge, solve learning problems or accomplish tasks with the assistance of verbal speech in the form of student-student talk or student-teacher talk. Students make their ideas available via communication to others for comment, suggestion and argument and their thinking is further developed by having to make sense of what others say to them. Irrespective of whether students substantiate their own claims or challenge their learning partner's proposals, their thoughts are articulated and ideas and concepts will become more refined (Light, 1993).

Although Geiger and Goos (1996) reported on how different types of talk were used in technology-based mathematics classroom, how classroom talk promotes statistics learning and statistical thinking in an IT environment is unknown. IT here refers to enabling students to have a more intuitive feel for the concepts being studied; serving students to alleviate computational burden; and implementing computer logic by students. An observation study was therefore conducted to examine how social interactions among students in small groups and the teacher's intervention were organised in statistical computing laboratory.

## Research Design

Since the observation study was set within a classroom, the research design and associated methods of collection and analysis of data were selected for their relevance to teachers and students as research participants. The participants included a teacher and 58 students enrolling in Year 2 of the Higher Diploma in Applied Statistics and Computing course offered by the Hong Kong Institute of Vocational Education. All the students had attained the elementary level of probabilistic and statistical concepts in their Year 1 study.

This cohort of students was selected because Regression Modelling is a module taught in their Year 2 study in which the teacher planned for improving classroom teaching practice by means of developing and adopting a model of statistical thinking and a cognitive model of correlation comprehension within an IT environment in which web resources and Excel were utilised with an emphasis on social processes of learning (cf. Li, 2009; Li & Goos, 2011). The delivery of the module follows a pattern of 2-hour lectures supported by 1-hour computing laboratory sessions in each of fifteen weeks. in Computing laboratory sessions were divided into small groups of two or three in order to increase students' opportunities for peer learning.

## Methodology

Through all laboratory sessions, students were offered hands-on practice in regression modelling, which also helped develop mastery of regression heuristics. While they were accomplishing various modelling tasks collaboratively with their teacher and/or learning partners, there was necessarily a substantial amount of talk between students. The students' conversations and student-teacher discourse were audiotaped and transcribed in full, with relevant excerpts being selected for further analysis. Peer talk was preliminarily analysed based on Mercer's (1995) categories: exploratory, cumulative and disputational. Talk is generally categorised as exploratory when students critically evaluate what they are told prior to accepting. As such, exploratory talk moves knowledge and understanding from the superficial to a more refined level. Students who respond to their learning partners positively without critically evaluating what they are told use cumulative talk. Disputational talk is developed when students challenge someone's proposal based only on their personal point of view. Fisher (1997) and Mercer (1995) pointed out that outcomes of collaborative learning had a close link with a specific talk category.

Peer talk was further analysed with the aid of the framework developed by Kumpulainen (1994). However, not all of Kumpulainen's classifications were observed in student conversations in the statistics classroom. Nevertheless, all utterances can be classified in one of the ways in Table 1 that shows common functions of classroom talk displayed in regression modelling work.

| Classifications | Description |
|---|---|
| Informative | Seeking information about data and problem background or knowledge previously learnt |
| Compositional | Deducing practical implications for regression parameters involving discussion of data context, scatterplot construction and hypothesis testing |
| Interrogative | Seeking learning partners' feedback or approval when puzzling about their own work |
| Judgmental | Conveying one's agreement or disagreement |
| Organisational | Organising ideas and wording when presenting statistical work or constructing persuasive lines of statistical reasoning |
| External thinking | Articulating one's thought when presenting statistical output aloud |
| Responsive | Showing one's participation in learning activities or expressing one's agreement to a less extent |
| Reproductional | Repeating learning partners' response and one's own response without any elaboration or critical evaluation |
| Affectional | Expressing one's personal feelings, for example, task accomplishment |
| Argumentational | Challenging someone's proposal or defending one's argument with concrete evidence |
| Expositional | Discovering things unfamiliar or unanticipated without detailed planning, such as interacting with data, studying problem context, looking for alternative approaches, etc. |
| Hypothetical | Proposing statistical ideas without providing any evidence or explanation |
| Heuristic | Formulating or regulating strategies for correlation appraisal, model fitting, model refinement, etc. |

Table 1. Classifications of talk during statistical work (modified from Kumpulainen, 1994)

In computing laboratory sessions, the teacher used talk to guide the construction of students' knowledge and orchestrate learning activities. Thus, the student-teacher talk was analysed using sociocultural perspectives derived from the work of Tharp and Gallimore (1988) and Mercer (1995). Mercer's framework (1995) was used to identify how the teacher elicited knowledge from students; responded to what students said; and recapped to re-organise, or call attention to the significant ideas students had just presented. The student-teacher talk was further analysed to report a finer-grained account of teacher-led discussion in the way that assisting students to learn, via modelling, questioning, cognitive structuring, contingency management, feeding back and instructing.

Within each of these discourse categories, teachers may elicit, respond, or recap. For instance, questioning can be used to elicit what students already know or how their understanding develops or misunderstanding arises. Alternatively, questioning can be used for responding to students if the teacher wishes to extend discussions. Questioning can also be used to offer directions towards task improvement or accomplishment after recapping students' useful ideas as hints.

## Research Findings

The teacher tended to intervene in student's learning activities with a computer in order to check the quality of understanding they gained and how students' thinking should be facilitated when they met with obstacles. He noticed that three students, A, B and C were puzzled as to how to graph and comprehend correlation data even though they had completed some correlation tasks. He came to their computer workstation and recalled what he discussed with all students in the lecture the day before to orient them to the task at hand. He drew their attention to a set of data and the use of Excel. They listened to the teacher's hint but did not show much of a response. Thus, he wanted to know what impeded their learning progress; and how he could offer learning assistance (see Excerpts 1-4).

| Excerpt | | |
|---|---|---|
| 1. | Teacher: | Before you use Excel, you read this set of data. Based on this context, you look at …<br>*(The teacher was pointing at the data on an Excel spreadsheet).*<br>What do you mean by the tax refund?<br>Do you know what is the meaning of tax refund?<br>*(Students A, B & C shook their heads to signal they did not know the meaning.)*<br>Let's say taxpayers, they paid tax in 1999. |
| 2. | A & B: | Hm! Hm!<br>*(A, B & C started to pick up the problem background.)* |
| 3. | Teacher: | The Financial Secretary said "Return part of personal tax back to the taxpayers." |
| 4. | B & C: | Hm! Hm! |

The assessment question, *"What do you mean by the tax refund?"* was used by the teacher to elicit what the students knew and understood. He found that progress was obstructed in the task of correlation comprehension because the problem context they were working on was different from the one they had discussed the day before. Thus, at this stage, he briefed them on contextual background of the problem. The students indicated their understanding during pauses in his briefing.

Excerpt

| | | |
|---|---|---|
| 5. | Teacher: | This is the amount. This is the percentage. You read this? This is the percentage.<br>*(The teacher referred the relevant data by pointing at their Excel spreadsheet.)* |
| 6. | C: | Hm!<br>*(C responded to showing she understood what was told.)* |
| 7. | Teacher: | And this is the monthly family income in thousands of dollars, OK? |
| 8. | A: | Hm! Hm!<br>*(The teacher explained the measurement unit of data.)* |

The teacher assisted retrieval of the meaning of tax refund by reiterating the variable names, content and measurement unit of tax refund data on students' Excel spreadsheet. This, he hoped, would facilitate the students' transition from understanding data to performing an appraisal by studying the data relationship.

Excerpt

| | | |
|---|---|---|
| 9. | Teacher: | You look (at the data)! Say, based on this context, do you think there is a relationship between the percentage of the tax refund spent within one month of receipt and the family income?<br>*(The teacher waited for about few seconds.)*<br>Do they have the relationship? |
| 10. | A, B & C: | Hm! Hm! |
| 11. | A: | OK. |
| 12. | Teacher: | *(The teacher had checked their answer on their laboratory worksheet.)*<br>You've just discussed, "There is a relationship."<br>And the next question is whether these data cover a reasonable and meaningful range. OK? |
| 13. | A, B & C: | Hm! Hm! |
| 14. | B: | OK. |
| 15. | Teacher: | What is the minimum value for the percentage in this case?<br>*(The teacher found A & B were sure about what was going on. So, he decided to leave them with the question.)* |

| | | |
|---|---|---|
| | | Read this question carefully and then I'll come back. |
| 16 | A, B & C: | OK. |

The teacher drew students' attention to recalling the data context and he posed a question, in Excerpt 9 to gauge the point at which the students should target. The students' verbal responses did not have any discourse context but the teacher found the response written on their laboratory worksheet confirmed their understanding. He recapped their answer and subsequent questioning was used as a means of assisting thinking associated with a logical extension of examining data.

To sum up, the students listened attentively to the teacher, but were not actively engaged with discussions initiated by the teacher. They only gave simple verbal responses to the teacher's questions but without attempting to give any elaboration or justification. Nevertheless, the students' written responses affirmed their understanding after instructing and questioning assistance offered by the teacher and so he handed over the responsibility for subsequent correlation tasks to them.

After the teacher had offered students A, B and C assistance, these students studied relationship between the variables on their own. Kumpulainen's (1994) and Mercer's (1995) frameworks were used to analyse the nature and contents of talk among students when they moved on to graphing correlation data together without teacher's assistance.

Excerpt

| | | |
|---|---|---|
| 17. | C: | Do we plot a straight line for the data? (**Interrogative**) |
| | | *(While A was thinking about what minimum value was for y-axis, C proposed to construct a scatterplot.)* |
| 18. | B: | It would be better to construct it (a scatterplot). (**Judgmental**) |
| 19. | C: | It would be more easy to judge. (**Judgmental**) |

Students A, B and C basically knew how to approach a correlation problem. C proposed to construct a scatterplot and sought her learning partners' feedback, using interrogative talk. At the same time, A had shown an implicit agreement and was thinking about what the minimum value was for the $y-axis$. This shows that A worked faster than her learning partners. B replied why she agreed with C's proposal and C explained why to construct a scatterplot using judgmental talk. The use of exploratory talk throughout this dialogue illustrated that their discussions helped them develop a more refined level of understanding of a scatterplot.

Excerpt

| | | |
|---|---|---|
| 20. | B: | Just key in the data! (**Organisational**) |
| 21. | C: | Yes, key in the data into Excel but we need to watch it carefully. (**Judgmental**) |
| 22. | A: | Be careful! (**Responsive**) |

23. C: Yes, otherwise we will be in trouble. (**Judgmental**)

Student B gave the instruction to input data into an Excel spreadsheet for subsequent scatterplot construction. Although C gave the same instruction, she reminded A and B to watch the data as well as the display of data meticulously upon each successive keyboard input and A agreed with her. Interestingly, B's instruction (Excerpt 20) was organisational as commanding a straightforward data input task, whereas C's instruction was judgmental in realising that incorrect data entry would spoil a scatterplot and would be difficult to rectify (Excerpts 21 and 23). That is, the entries appearing on the dialog box of Excel graphing tools were retained (hard-coded) and could not be overwritten. Any incorrect entry had to be deleted completely and then re-entered, otherwise this would create a serious problem if great care were not taken with data entry. A's talk was responsive to agree and alert to input data correctly (Excerpt 22). In the ensuing segment their talk was cumulative aiming at preparing data for scatterplot construction using Excel and did not call for any critical evaluation (Excerpts 20-23).

Excerpt

24. A: 70, 55, 100, … , OK? (**Interrogative**)

*(A keyed in the data.)*

25. C: 13 (**External thinking**)

*(A keyed in the data.)*

26. A: 13 (**External thinking**)

.
.
.

32. A: 2, 4, 6, … six pairs of data (**Judgmental**)

*(A constructed a scatterplot.)*

After student A had read the data aloud when keying, she used interrogative talk to seek her learning partners' agreement (Excerpt 24). They did not respond, but soon after, C read the data aloud and A keyed in the data. A provided feedback to what data was heard and had already been keyed in. The talk displayed mostly an external thinking function, monitoring data entry actively during keyboard input (Excerpts 25-31). Prior to scatterplot graphing, A's talk displayed a judgmental function, checking for the correct number of pairs of data inputted, because graphing correlation required the data to be in pairs (Excerpt 32). The nature of the talk was cumulative, revealing the way they all closely monitored data entry before graphing. This would enable them to correct their mistakes more promptly leading to the basic requirement of graph construction, that is, presenting proper format, layout and axis orientation of a graph.

| | | |
|---|---|---|
| 33. | C: | 120 (%)? The graphing tool enlarges the y-scale. (**Expositional**) |
| 34. | B: | Over-scale, right here! (**Judgmental**) |
| | | *(C pointed at 120% shown in y-scale.)* |

The function of talk became expositional at the time C discovered a y-value of 120% in the scatterplot constructed by A as displayed on their computer monitor. She queried the legitimacy of 120% because she believed the Excel graphing tool enlarged the y-scale, ending up with the y-value of 120%, thereby exceeding its meaningful data range within the context of tax data. Of course, 100% was the maximum percentage of amount of tax refunded that could be spent. 120% would represent an over-spending of the amount of tax refunded, but this was not acceptable. B's talk showed judgmental function when she admitted C's discovery and pointed out the over-scale problem resulting from an extraordinary percentage, 120%.

Excerpt

| | | |
|---|---|---|
| 35. | A: | Are the axes swapped? (**Interrogative**) |
| 36. | C: | Yes, the axes are swapped. (**Judgmental)** |
| 37. | B: | No! No, it was right! It was right. These are … (**Argumentational**) |
| 38. | C: | Here is what? (**Argumentational**) |
| | | *(C was pointing at the x-axis.)* |
| 39. | B: | These are x (-values). The maximum x-value is 100 and this should represent x. But the axis scale does not contain 100 and the maximum is 70. Therefore, this scatterplot is correct. (**Argumentational**) |
| 40. | C: | Doesn't this (y-)axis represent percent? (**Argumentational**) |
| 41. | A: | The data had interchangeably been keyed in. (**Organisational**) |
| 42. | B: | The data had interchangeably been keyed in.<br>Oh yes! You're right. Click! (to swap the data input) (**Judgmental**) |
| | | *(A swapped the data input.)* |
| 43. | C: | x-values should be here. (**Judgmental**) |
| 44. | A: | This should be for y-values. (**Judgmental**) |
| 45. | B: | Aha! Aha! (**Affectional**) |

With the over-scale problem ignored, student A queried the correctness of the axis orientation used in their scatterplot but she received different responses from B and C (Excerpts 35-37). C answered, "*Yes, the axes are swapped*" in supporting A's query, and sounded more confident with her own answer. When B was insisting the axis orientation was correct, C interrupted and challenged B, "*Here is what?*" while pointing at the x-axis. B defended her answer aloud in response to C's challenging question but B did not articulate her thoughts when checking whether or not the values presented in the x-scale made sense. She was still holding a wrong answer. C found B's defence did not make sense so she challenged B further by asking a more specific question, *"Doesn't this (y-)axis represent percent?"* When B was thinking about C's question, A proposed a way of rectifying the answer and announced, *"The data had interchangeably been keyed in."* A's proposal clarified B's thinking, which then helped her to recognize her misunderstanding, B then commanded, *"Click!"* to correct the mistake. The interaction enabled them to explore subtle differences between the orientation of the x-axis and y-axis that evolved from the regression problem, thereby demanding the strategic level of statistical thinking. Within the strategic level, thinking is associated with predicting something unknown based on one's personal view and judgement emerging from a statistical perspective or methodology; and devising a scheme or plan for achieving a particular objective related to statistics.

Although the talk among the three students (Excerpts 35-45) showed mainly concern for data entry, they still found the axis orientation flaw owing to improper order of data entry, that is x-values and y-values were swapped in the scatterplot they constructed. Student A initially used interrogative talk when spotting the problem in axis orientation and C employed judgmental talk to express her agreement with A's query. Subsequent talk between B and C (i.e., Excerpts 37-40) exhibited an argumentation function as B defended her answer and C challenged B. The divergent views between B and C were reconciled by A's organisational talk that announced a swap of the data input. After the data swap, A's and C's talk was judgmental to declare the axis orientation was now correct. B's expression *"Aha! Aha!"* was affectional in nature to express task achievement. The successful outcome of this collaborative learning episode, that is, making a concerted effort to correct the axis orientation, resulted from exploratory talk (i.e., Excerpts 35-45) that critically evaluated and changed the axis orientation and refined the students' understanding of Excel graphing conventions.

| Excerpt | | |
|---|---|---|
| 46. | B: | Title … (**Organisational**) |
| 47. | A: | The chart title should be (**Organisational**) |
| 48. | C: | Oh! The title … (**Organisational**) |
| 49. | B: | Should be … (**Organisational**) |
| 50. | C: | The relationship between the … (**Organisational**) |
| 51. | B: | The percentage of the tax refund spent within one month of receipt and the monthly family income (**Organisational**) |
| 52. | A: | Something like that …. percentage of the tax refund … (**Organisational**) |

*(A talked while keying in the scatterplot title.)*

| | | |
|---|---|---|
| 53. | B: | It's too long. (**Organisational**) |

Students A, B and C attempted to give a title to their scatterplot by turns but they could not summarise what the scatterplot intended to show. Their talk here (Excerpts 46-49) was organisational in nature while maintaining an interaction among themselves and inviting their learning partners' suggestions. When drafting the title, C grasped a few words and announced, *"The relationship between the ... "* and B supplemented, *"The percentage of the tax refund spent within one month of receipt and the monthly family income"*. A consolidated the titles both B and C suggested. In so doing, language, thoughts and actions were linked when A keyed in the title on the scatterplot. B said, *"It's (The title's) too long."* A probably agreed with B and summarised the title concisely. B and C agreed with the title amended implicitly. Their talk (Excerpts 50-53) was organisational in nature. Overall, the talk was cumulative as all three composed and put forward the title of a scatterplot to convey its central theme. This composition task did not deal with critical evaluation, but they placed emphasis upon the conciseness of the title of a scatterplot.

Excerpt

| | | |
|---|---|---|
| 54. | A: | The x-axis label? (**Organisational**) |
| 55. | C: | (The labels of x-axis and y-axis were) income in thousands of dollars … (and the) percentage of the tax refund (spent respectively). (**Organisational**) |
| | | *(A keyed in the labels of x-axis and y-axis.)* |

To complete the task of scatterplot construction, it is necessary to give labels for the x-axis and y-axis. Thus, A asked her learning partners, *"The x-axis label?"*; C replied with the labels of both x-axis and y-axis. The question-and-answer had an organisational function, describing what the x-axis and y-axis represented. This is a typical type of cumulative talk, not involving critical evaluation.

Excerpt

| | | |
|---|---|---|
| 56. | A: | It looks like we should exclude the 120 (% in the scale of y-axis)? (**Interrogative**) |
| | | It is unreasonable to have 120 as it is over-scale. (**Compositional)** |
| 57. | B: | It looks like we (should) have (this value). No need to change. (**Judgmental**) |
| 58. | A: | We quit from here (the Excel scatterplot) first. (**Hypothetical**) |

| | | |
|---|---|---|
| 59. | B: | It looks like we should go back (to) the previous dialogue box to re-scale this (y-axis). Quit from here first. (**Heuristic**) |
| 60. | A: | It's about here (y-axis). Click or right-click the mouse? (**Interrogative**) |
| | | *(They all laughed.)* (**Affectional**) |
| 61. | C: | Wait! Click. (**Judgmental**) |

Student A alerted them to revisit the over-scale problem and proposed excluding 120% together with her justification that this was over-scale and absurd within the context of tax data. A said, *"It looks like we should exclude the 120 (% in the scale of y-axis)?"* with an interrogative tone when seeking B's and C's feedback. A's justification was compositional in nature (Excerpt 56) because she deduced an implicit but practical implication of the percentage of tax refunded that was spent, that is, indicating 120% was an out-of-range percentage as the percentage of tax return could not be greater than 100%, the amount of tax paid. Although B disagreed with A, *"... No need to change"* (Excerpt 57), neither debates nor discussions arose. This was simply because B did not challenge A, and eventually conceded the need for reformatting the y-scale. Thus, B's utterance was judgmental rather than argumentational. A said, *"We quit from here (the Excel scatterplot) first."* to suggest what to do in Excel. The context of her speech was hypothetical in nature, proposing a step for rectifying the y-scale in Excel but without providing any explanation or clear procedures. The procedures, *"It looks like we should go back (to) the previous dialogue box to re-scale this ( y-axis)."* formulated by B had heuristic functioning. At the time, A was pointing at the y-axis with a mouse pointer, she was concerned with the correct mouse action and asked, "*Click or right-click the mouse?"* to prompt the "Format Axis" dialogue box in Excel. Her utterance was interrogative in nature when seeking her learning partners' advice regarding a mouse-click action. They all laughed to signify they had confidence in accomplishing the correlation tasks and such expression was affectional in nature. Finally, C announced, *"Click"* that is, judgmental when affirming A's mouse-click action.

The above conversation illustrated the use of various types of talk: interrogative, compositional, judgmental, hypothetical, heuristic and affectional to suit different needs for achieving certain purposes or accomplishing specific tasks. Although the axis-reformatting tasks had not much critical evaluation involved, the talk can be classified as exploratory as implicitly deducing a practical implication of the percentage of tax refunded that was spent and formulating procedures for rectifying the y-scale.

Excerpt

| | | |
|---|---|---|
| 62. | B: | Underline (the title). (**Organisational)** |
| 63. | A: | Underline looks ugly. (**Organisational**) |
| 64. | C: | What's this? (**Interrogative**) |
| 65. | A & B: | This is the title. That's all about it. (**Organisational**) |
| 66. | B: | Enlarge the scatterplot a bit. (**Organisational**) |

| | | |
|---|---|---|
| 67. | C: | OK. (**Organisational**) |
| 68. | A: | This is the scatterplot title. (**Organisational**) |

To make their scatterplot more eye-appealing, they proposed enhancing its layout. B suggested underlining the title of their scatterplot. Yet, A found this ugly so she undid title underlining. C asked, *"What's this?"* to draw their learning partners' attention to checking the wording of the scatterplot title. Both A and B replied, *"This is the title."* B suggested enlarging the scatterplot; C agreed, and A accomplished the task. Their talk relevant to the scatterplot enhancement tasks was mainly organisational in nature. Interrogative talk was used only when C wanted to draw their learning partners' attention to checking the wording of the scatterplot title. Summing up, the talk was cumulative when accomplishing the straightforward task of layout enhancement of the scatterplot.

Excerpt

| | | |
|---|---|---|
| 69. | Teacher: | Yes, this is good! |
| 70. | A, B & C: | Hm! [inaudible] |
| 71. | Teacher: | In your labelling (graph title), you can simplify this. Just say, the percentage of tax refund spent. I can tell you, that's nothing wrong with your labelling. |
| 72. | A, B & C: | Hm! [inaudible] |
| 73. | Teacher: | You don't have enough rooms sometimes; so we just grasp or pick up the keywords. |
| 74. | A, B & C: | Hm! [inaudible] |
| 75. | Teacher: | When you present the graph to audience, so explain what you mean by percentage of tax refund spent. … You understand what I mean? |
| 76. | A, B & C: | Hm! [inaudible] |
| 77. | Teacher: | If there is not too much room for you to put down the long labeling (graph title), just pick the keywords. |
| 78. | A, B & C: | Hm! |
| 79. | Teacher: | This is good! *(The teacher was pointing at the graph title they had just revised with a grasp of keywords.)* |
| 80. | A, B & C: | Hm! Hm! |
| 81. | Teacher: | Good axis scales and labelling! 0%, … , 100% because the maximum percentage of tax refunded you can spent. *(The teacher was pointing at the 100%.)* |

| | | |
|---|---|---|
| 82. | A, B & C: | Hm! Hm! |
| 83. | Teacher: | Very good! |

It was observed that the students became self-directed and could spot and correct graphing mistakes without the teacher's assistance. However, talk among students involved the teacher when he intervened in their learning activity to check their progress. Thus, the following analysis of the student-teacher talk employs Tharp and Gallimore's (1988) and Mercer's (1995) ideas. Contingency management in the form of praise was offered by the teacher in different circumstances to build students' positive learning experience. The first example of praise (Excerpt 69) was an evaluative comment provided to confirm a correct title they gave to their scatterplot. The second example of praise (Excerpt 79) was given to acknowledge the students' revised, and more concise, scatterplot title. The third example of praise (Excerpt 83) was offered to reflect the overall quality of their scatterplot including a concise title, correct axis labels and reasonable axis-scales. All these instances of praise (contingency management) were offered as responding to the students' scatterplot graphing. The students were also offered various forms of instructing assistance by the teacher to refine the title of their scatterplot (Excerpts 71, 73, 75 and 77). The teacher gave positive feedback on the scatterplot they constructed, particularly axis scales and axis labelling before this graphing task drew to the end (Excerpt 81). During this period of student-teacher interaction, the students listened to the teacher attentively and gave verbal responses, *"Hm! Hm!"* showing their participation and expressing their agreement with the teacher's praise and instruction. The students also gave a non-verbal response to the teacher's instructing assistance, that is, by revising the title of their scatterplot in Excel. The teacher recapped the students' scatterplot title displayed on their computer so as to develop subsequent instructing assistance.

Students A, B and C displayed different levels of understanding in approaching a correlation problem. C had a very limited understanding of the goal to be achieved but B knew what to do next and A had already started thinking towards the goal, that is, determining the y-scale for graphing correlation data. Without teacher's intervention, social interaction among students was maintained in high level in the situation where the three students demonstrated their own awareness of the over-scaling problem and took great responsibility for revising the axis scales, axis labels and title of a scatterplot when programming Excel by turns.

The high use of the argumentational function in the student talk was an effective means of provoking deeper exploration of data content as this steered their discussions away from mere information exchange. Specifically, B defended her own answers whereas C challenged her answers.

The teacher intervened in their learning tasks and provided evaluative feedback on the quality of their scatterplot graphing. He recapped the data context and gave instructing assistance to his students in improving the title conciseness of their scatterplot. All of these actions represented contingency management in reinforcing and rewarding the students for their work.

## Conclusion

This observation study has provided insights into patterns of student-student and student-teacher talk in a statistics classroom operating in an IT environment. The samples of dialogue analysed in this paper do not include all students participating in the study, but were selected because they are representative of the kind of talk observed throughout the observation period.

With regard to student-student talk, the evidence presented here suggests that students were active participants and held a common conception of what could be achieved cooperatively. Almost all of the talk analysed in this paper was relevant to the tasks at hand, and there was no evidence of Mercer's disputational pattern of talk, where opinions are presented and disagreements emerge without attempt at justification. Most of the students' talk was exploratory and focused on a particular theme related to the task, or segment of a task, that students were tackling. Exploratory talk was observed when it was necessary for students to use higher order thinking to accomplish more sophisticated learning tasks. A few instances of cumulative talk were observed, when straightforward tasks such as scatterplot comprehension were attempted. In these circumstances, students proposed ideas or accepted the ideas of their learning partners without finding it necessary to give or seek justification. So both exploratory and cumulative talk proved to be valuable for knowledge construction.

When working together in the absence of the teacher, students were more vocal and the content of talk was richer, illustrating the use of various types of talk: interrogative, compositional, organisational judgmental, hypothetical, heuristic, external thinking and affectional to suit different needs for achieving certain purposes or accomplishing specific tasks. There was also evidence that group interaction was associated with positive affective responses so that these tasks and the talk that they promoted, may have been beneficial in building social relationships and fostering rapport between students.

Analysis of the episodes presented in this paper showed how the teacher, through pursuing specific learning objectives associated with development of statistical thinking, was able to guide students' talk and reasoning. The teacher aimed to act as a facilitator of student discussion and exploration. He made decisions about when to supplement students' knowledge and skills, when to leave them to solve problems on their own, and when to use questioning and other means of assistance to stimulate thinking, direct actions, or promote intellectual exchanges between students.

Questioning was used frequently to discover what the students knew, understood, or misunderstood, and to offer direction towards deeper thinking at times when students could not otherwise make progress on tasks. The teacher also used modelling assistance to help students see how to assemble and organise pieces of knowledge they might have already grasped or possessed. Contingency management was another form of assistance exhibited in the form of praise that affirmed the quality of students' work under three different circumstances: building, maintaining, or bolstering their confidence. To situate learning within students' capabilities, the teacher offered cognitive structuring that assisted them to organise and justify various aspects of a regression modelling problem but left room for students to regulate their strategies based on their own creation and interpretation of a regression model they found was the best. The teacher would only use instruction if he thought that students felt threatened by questioning. This analysis demonstrated key roles played by a teacher in orchestrating social interaction between students in an IT environment that were aimed at developing statistical thinking.

The findings of these analyses of talk in a statistics classroom are grounded in sociocultural theories of learning. The analytical frameworks revealed how talk structured thought in the context of correlation analysis, and how the nature of tasks was associated with different patterns of talk. This study suggests that tasks should be designed to encourage co-operation rather than independent work or competition between students.

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