AN ANALYSIS OF PATTERNS OF CLASSROOM TALK IN AN IT ENVIRONMENT

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Classroom talk plays a significant role in a teaching and learning process, but how classroom talk promotes statistics learning and statistical thinking is not clearly known. An observation study was therefore conducted to analyze student talk while collaboratively working at computers. When attempting the task of deriving the meaning of a scatterplot, the talk was cumulative as utterances built up ideas without critique. When handling more sophisticated tasks, i.e., assessing the strength and direction of data relationship and quantifying the relationship, exploratory talk was used for taking knowledge and understanding to more refined levels via critical evaluation. There were some discrepant features between these two types of talk; cumulative talk was affectional and reproductional in nature, whereas exploratory talk displayed expositional feature and external thinking.

INTRODUCTION

Although research studies (e.g., Pfannkuch & Budgett, 2016; Schau et al., 2012) report how to improve statistics teaching and learning, little attention was paid to social context of statistics learning. But, in fact, learning is a social process through which students interact among themselves or with their teacher. They make their ideas available via communication to others for comment, suggestion, and argument such that their thoughts are articulated and ideas as well as concepts will become more refined (Vygotsky, 1978).

Goos (2009) reported a finer-grained account of teaching and learning practices using technology in secondary mathematics classrooms using a sociocultural framework in the following way. A community of inquiry was established in the way that the teacher clarified misunderstandings, structured students' thinking, and moderated discussion among students. Through discussions, the students came to see the same problem differently and proposed interpretations of problem settings leading to different approaches to problem-solving. To respond to their peers' feedback or different approaches, they communicated their own beliefs, ideas, and understanding, thus making different contributions and generating a more comprehensive view of the problems they were asked to solve. Evidently, classroom talk plays a significant role in a teaching and learning process, but how classroom talk promotes statistics learning and statistical thinking is not clearly known. An observation study was therefore conducted to address the research question of what patterns of student talk would stimulate students' thinking and broaden their perspectives on problems via peer collaboration within an IT environment.

OBSERVATION STUDY

Fifty-eight student participants in the observation study, ranging in age from 19 to 22 enrolled in Year 2 of the 3-year Higher Diploma in Applied Statistics and Computing (HDASC) course aiming at equipping students with statistical knowledge and skills to solve practical problems with the aid of computer software. Upon completion of the course, they would join the statistics workforce.

To judge the applicability of sociocultural theories of learning, the teacher in the present study (the first author of this paper) taught the Regression Analysis module in the HDASC course focusing on social processes of learning. The delivery of the module follows a pattern of a 2-hour lecture supported by a 1-hour computing laboratory session each week. In computing laboratory sessions, students were divided into small groups in order to increase opportunities for peer learning. Each group of students shared the same computer and monitor, and took turns in keying data and programming Excel as they worked together on the set tasks. While they were accomplishing various tasks collaboratively with their peers, there was necessarily a substantial amount of talk between students.

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Peer conversation was therefore audio-recorded and the conversations were transcribed in full, with relevant excerpts being selected for analysis. Preliminary analysis was conducted with the aid of the framework developed by Mercer (1995). Talk among students is generally categorized as exploratory when students critically evaluate what they are told prior to accepting. Students who respond to their peers 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. Apparently, the first two categories of talk display positive interaction, whereas the last shows negative. The framework is therefore useful for showing whether social interaction is positive during collaborative learning; positive interaction enhances students' motivation to learn (Elliot & Dweck, 2005).

Student talk served for various purposes and was further analyzed using Kumpulainen's framework (1994) that could specify functions of talk when attempting correlation tasks. The functions could be: (a) intentional, (b) responsive, (c) affectional, (d) reproductional, (e) experiential, (f) interrogative, (g) informative, (h) organizational, (i) compositional, (j) imaginative, (k) external thinking, (l) judgmental, (m) argumentational, (n) expositional, (o) heuristic, and (p) hypothetical. The first six functions, (a)-(f) are in social nature for initiating and maintaining active communication; the middle four functions, (g)-(j) are mainly for attempting low-collaborative tasks; and the last six functions, (k)-(p) feature very largely in high-order of thinking.

A number of factors influenced the selection of data for the analysis of student talk. Students participated in this study on a voluntarily basis, so only a few students agreed to have their dialogue audio-recorded (whereas all agreed to participate in other aspects of the study, such questionnaires and interviews). Among these students, some appeared to be anxious at the prospect of having their conversations audio-recorded, and as a result talked less frequently and less audibly. Therefore, the conversation of only one pair of students was available for analysis; these students were identified by codes, P and S. The following analysis thus uses excerpts from their conversations.

The general correlation concepts and how to use a scatterplot to study correlation were discussed in the lecture before the computing laboratory session. In the laboratory session, both students were assigned a laboratory exercise that demanded the analysis and design of the solutions. They worked together to accomplish four learning tasks in the exercise which were designed and arranged into the hierarchy in accordance with the practice of statistics. After experimenting with given data by using a visualization tool available on the web, they were asked to derive the meaning of a scatterplot in the first task because a scatterplot is a visual approach to exploring statistical relationship between quantitative variables more efficiently especially in handling big data, whereas correlation coefficient is a computational tool for checking the relationship more precisely. Then, they evaluated the strength and direction of data relationship in the second and third tasks respectively. The third task must follow the second task; otherwise it would not be meaningful if little strength (i.e., no data relationship) is found in the second one. After accomplishing the first three tasks, students should be able to attempt the task of correlation appraisal that is compulsory prior to building any regression models. They should report the quantitative relationship, namely correlation coefficient by assessing the correlation of data in the given scatterplots using digital tools, such as computer, monitor, keyboard, and interactive tool.

RESEARCH FINDINGS

Analysis results of student talk are elucidated in the following subsections by way of illustration, that is, the contents of a dialogue between students, P and S in excepts 19-23, 40-69, 72-83, and 94-110 when attempting the tasks of scatterplot comprehension, evaluation of the strength and direction of data relationship, as well as correlation appraisal respectively.

Task 1: Scatterplot Comprehension

The initial function of student talk was for social exchanges to maintain an active dialogue and involvement in collaborative tasks using interrogative, responsive, and reproductional utterances. The functions of these utterances had subsequently changed to suggest a task approach or seek a peer's social approval, displaying interrogative tone. They gave feedback or showed agreement using responsive and reproductional talk. Frequent use of organizational talk (Excerpts

19-23) was displayed as assembling and organizing pieces of knowledge they might have already grasped or possessed. This demanded articulation of thoughts.

Excerpt

1. S: Briefly explain what a scatterplot is. (Interrogative)
2. P: Briefly explain. (Responsive)

...

19. S: I'm talking about "with" the …. with corresponding … (Organizational)

...

23. S: Will "each" be clearer? (Organizational)

...

27. S: We have good communication. (Affectional)

...

In the last part of their conversation, they expressed pleasure at task accomplishment as well as collaboration. The talk was mainly affectional. Cumulative talk was evident from verbal responses that illustrated unquestioned acceptance of a peer's answers.

Task 2: Strength of Data Relationship

Many students confused the concepts of strength and direction of the data relationship, so the following two tasks were set to experiment with given data using interactive tools through which they could manipulate scatters of data. Like most students, S and P did not have a firm grasp of the concepts, they discussed how to approach the tasks using interrogative, responsive, and reproductional talk as showing their initiative, proposal, and participation in collaborative tasks.

...

40. S: It is more and more negatively correlated when the … (Expositional)
41. P: When the correlation coefficient … (Expositional)
42. S: When the button (of the visualization tool) moves to the right, … (Expositional)
43. P: When the correlation coefficient, r becomes –1 and the slope becomes negative. (Expositional)
44. S: What is the switched sign? (Interrogative)

...

51. P: Positive (External thinking)
52. S: Yes, becomes positive (Responsive)
53. P: Yes! (Judgmental)

...

67. S: When the number (correlation) is around 0, … (Expositional)
68. P: (The points are) very dispersed (Responsive)
69. S: Yes, very dispersed; the value's (correlation coefficient) in the middle. (Expositional)

...

Their dialogue (Excerpts 40-69) displayed high-order of thinking; the high amount of the use of expositional function was for sorting out how data scattering illuminated the strength of data relationship. In addition, external thinking and judgmental talk showed that they critically evaluated each other's verbal responses. Interrogative function was also used to check their understanding with one another to make sure they grasped the concept correctly. Recaps of one

another's speech were evident from informative and responsive talks to associate with a statistical term and extended discussion.

Task 3: Direction of Data Relationship

Both students further discussed how the correlation coefficient changed with respect to the direction of data relationship when manipulating scatters of data. They took turns to illustrate the "direction of data relationship" concept. Their dialogue (Excerpts 72-83) displayed various functions but was expositional and responsive, in nature mostly when playing the active role of checking the direction of data trend on the scatterplot. They appeared to be interacting closely with each other's thinking by supplementing each other's partial answers with justification or elaboration based on personal insight. Despite this, they used expositional speech when they were puzzled.

72. S: Direction? Direction? Now we should tell whether it's (the data pattern) going upward or downward. (Interrogative)

73. P: Yes! (Responsive)

74. S: We can see that when the r is …. (External thinking)

75. P: Very close to –1 (Expositional)

76. S: … very close to –1, it is a downward slope. (Responsive)

77. P: Yes! (Responsive)

78. S: … and this is its direction. The correlation increases (Expositional)

79. P: to +1 (Expositional)

80. S: … very close to +1, the slope is, … (External thinking)

81. P: Positive … (Expositional)

82. S: … going upward (Expositional)

83. P: going upward (Reproductional)

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On the other hand, "Yes!" responses were frequently used to confirm a peer's answers arising from data exploration, thus building confidence. Besides, external thinking was evident from articulation of thoughts when presenting statistical output aloud. Using Mercer's (1995) framework, their dialogue was categorized into exploratory talk in which both students engaged critically but constructively with each other's ideas.

Apart from using dialogue, they experimented with data scatters using an interactive tool and a mouse to contrast the spatial association between pairs of data and inspect whether the data condensed. The approach they adopted follows the second cycle of pattern recognition-integrative process in the cognitive model of correlation comprehension (see Li & Goos, 2011). They then illustrated to check each slope associated with each pair of neighboring data points, that is, the third cycle of pattern recognition-integrative process. Finally, they summarized slopes associated with pairs of neighboring data points to determine whether a linear relationship was positive or negative.

This excerpt demonstrated a high degree of mutuality in this learning process as the two students came to a clear understanding of conceptual meaning of the "direction" of data relationship. The knowledge was socially constructed by means of language – a tool for sharing thought and understanding.

Task 4: Correlation Appraisal

Both students made every endeavor to appraise the correlation in the data by reporting the quantitative relationship between two variables. The appraisal task involves the pattern recognition-interpretive cycle in the cognitive model of scatterplot comprehension (see Li & Goos, 2011). They watched interactive displays of how correlation changed with the scattering of data

while manipulating data points on a scatterplot by clicking and dragging their mouse. They checked how the correlation coefficient changed. They discussed its strength and direction of linear relationship. Apparently, the tool enriched correlation understanding as mapping a graphical representation of correlation into a numerical representation.

The students employed a variety of talk functions, argumentational, judgmental, responsive, expositional, affectional, external thinking, and interrogative but only external thinking and interrogative talk were fully utilized. They were interchangeably used in their dialogue. External thinking was evident from the voice that drove self-evaluation and articulated one's own thought when proposing answers, whereas interrogative talk was used when seeking a peer's feedback or approval.

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94.	S:	It can still form a straight line but … the deviation is quite large, I think ... (External thinking)
95.	P & S:	So, the r is? (Interrogative)
96.	S:	I will say that it is moderate, but how about you? (Interrogative)
97.	P:	Moderate? I agree because I think it is more condensed than this one. (External thinking)

...

101.	S:	The direction is of course going downward. (External thinking)
102.	P:	I think … I think so. I think the correlation coefficient is negative something. (External thinking)
103.	S:	Negative zero point …, what? Is the figure like this one? Is it? (Interrogative)
104.	P:	Is it? Yes. (Judgmental)
105.	S:	So, we can try to … (make use of the interactive tool). Is it like that? (Interrogative)
106.	P:	No, not really! Let me see. (Expositional)

...

110.	P:	Just have a good guess! OK! (Affectional)

After S had used the interactive tool to form data patterns matching to their scatterplot so as to check their answer, P queried about the data patterns using expositional talk (Excerpt 106). S showed the data patterns by putting a pen upward and then moving it to downward.

To sum up, students' dialogue displayed some characteristics of exploratory talk (interrogative, expositional, and argumentational), but the most striking feature was the high level of external thinking as the students attempted to apply their new knowledge to a specific task. In addition, they utilized the digital tool for learning through interaction with data patterns that would re-organize recognition-interpretive process in the cognitive model of correlation comprehension.

CONCLUSION

This study reported significant roles of IT in statistics learning. First, IT enabled the students to develop conceptual understanding of correlation concepts after experimenting data by using a visualization tool on the web, thus achieving communication effectiveness in statistics. This is essential for collaborative tasks in the statistical workplace. Second, IT has an educational role in organizing the learning environment to promote interaction between the two students, P and S; S initiated most discussions and offered scaffolding assistance or played the leading role. Her peer, P initially lacked but subsequently developed confidence and thinking which were displayed in her utterances in statistical context.

Moreover, the function of classroom talk and the content of dialogue associated with students' development of statistical thinking depended on the nature of statistical tasks the students

had. When deriving the meaning of a scatterplot, students employed self-assisting strategies through joint effort using cumulative talk exhibiting simple verbal exchanges. They accumulated and accepted but did not justify or debate what they were told. Exploratory talk was also used to escalate a higher-order of thinking to accomplish more sophisticated learning tasks, conceptualization of the strength and direction of data relationship as well as correlation appraisal, ending up with pleasure accomplishment as well as well as collaborative interaction. This illustrated the value that the talk might have for building social relationships and fostering rapport in collaborative learning.

Students developed conceptual understanding of the strength of data relationship from their own observation of the data patterns they were exploring or manipulating with the aid of an interactive tool. They prompted them to clarify, elaborate, and justify their own and each other's assertions at the same time. The dialogue between these two students mostly follows a pattern of expositional and interrogative speech. Expositional speech was to put forward proposals, whereas interrogation was to require further elucidation or clarification. Their exploratory talk typified talk which requested clarification with responses which provided elaborations and justifications as the learning task moved on to study the direction of data relationship.

After accomplishing the second task, their dialogue had a slight change of pattern; expositional and reproductional talk was used interchangeably. Expositional talk was to offer clues or suggestions and reproductional talk was to show acceptance. The dialogue was exploratory and exhibited in a form of discussion holding to a common conception of what was to be achieved cooperatively. The task accomplishment was derived from productive interaction.

Correlation appraisal enlisted thinking and reasoning rather than merely conceptual understanding, the content of their talk thus became richer and more exhaustive in thinking context using mostly external thinking and interrogation. Illustrative use of external thinking was evident from demanding that the way of thinking was supported or taken seriously by a peer and articulation of thoughts for self-evaluation of the answers they had given. Obviously, interrogation served to fulfill the demand.

The findings resulting from this analysis of talk in a statistics classroom are grounded in the sociocultural theories of learning but do not provide exhaustive illustration of talk that might facilitate statistics learning within an IT environment as involving only a pair of students because of few students participating in this study, poor quality of audio recording, and limited resources.

The students concentrated on task accomplishment, maintained collaborative interaction, and used digital tools to aid learning or accomplishing learning tasks, especially in reading scatterplots, it would thus be of interest to conduct another observation study to investigate the relationships between digital tools, learning tasks, and students.

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