PHILIPPINE JOURNAL OF LINGUISTICS
Volume 34, Number 2 & Volume 35, Number 1
December 2003 & June 2004

SPOKEN DISCOURSE IN THE TERTIARY MATHEMATICS CLASSROOM

Gladys C. Nivera
Philippine Normal University

Until recently, it has been assumed that mathematics transcends language factors. This belief is so pervasive that many bilingual education policies have promoted mathematics as one subject that can be taught in the students' weaker or second language (Khisty, 1993). Such is the case in the Philippines. Mathematics teachers are observed to distance themselves from issues concerning language use in their classrooms in the belief that mathematics and language learning do not mesh.

But communication in the classroom is largely facilitated through language, and meaning is mediated through communication. Thus, contrary to the popular notion that mathematics and language lie at the opposite ends of a spectrum, they are in fact complementary: Language is a major vehicle for content learning in the same manner that engaging in meaningful content is a vehicle for language learning.

Mathematics is a difficult subject to explain partly because it requires a specialized language to communicate mathematical ideas and also because the ideas themselves are not straightforward. It has its own register where words take on specialized meanings. Aware of the language connections in mathematics, the Professional Standards for Teaching Mathematics (NCTM, 1991) has called for unparalleled attention to classroom discourse where communication is seen as central to students' formalization of mathematical concepts and strategies. As Greenes and Schulman (1996) point out, communication is a way of revealing the students' thinking and reasoning and what they know and do not know. Further, according to Orton and Wain (1994), language allows thoughts to surface to a level of awareness where individuals can review them and clarify or modify their ideas. Thus, one important role of language is to bring to light students' different ideas with the hope that misconceptions will be resolved.

While various studies have looked at classroom interaction across levels and subject areas (see Genuino, 2000; Inductivo, 1994; Inocencio, 1992; De la Cruz, 1991; Beluso, 1989; Bautista, 1987; Bacungan, 1986; Penaflorida, 1986; Santos, 1984), none of them has looked closely at the spoken discourse in the tertiary mathematics class.

According to The International Commission on Mathematical Instruction (ICMI) (1997), teaching methods in the university tend to be more conservative and traditional. It is also observed that less effort is made in the tertiary level to deal with the backgrounds and needs of the students.

Such observations cannot be farther from the truth. The fact is many university mathematics teachers assume that our responsibility is primarily to present the material clearly; learning the material and passing the course are the responsibilities of the students.

Few of us reflect on the quality of our interaction with the students and the role of language in the classroom. This should not be the case.

In order to direct us teachers to desirable changes, there is a need to heighten our awareness of what is going on in the classroom, particularly with respect to how our language use facilitates or impedes student learning. For language teachers, with the implementation of the Revised Basic Education Curriculum (RBEC) and the adoption of Content-Based Instruction (CBI) for English, now more than ever, there is a need to articulate the nature of the spoken discourse in the mathematics classroom so that language teachers, by that I mean mathematics teachers as well, may be better able to address its needs.

This paper presents the results of a research that tried to analyze the spoken discourse in the tertiary mathematics classroom.

The research investigated three areas of spoken discourse in the classroom: teacher talk, student talk, and language use. With respect to teacher talk, it looked at how language is used in the mathematics classroom in terms of the cognitive levels of the teacher's questions and the questioning strategies the teacher employs. Hassard's (2000) binary system was used in classifying the cognitive level of the teacher's questions. The questioning strategies, on the other hand, were adopted from the studies of French and Maclure (1981) and Tarone (1983).

Student talk was described and analyzed in terms of their length and syntax, and the student's response rate to questions. Language use was analyzed in terms of the ratio of teacher talk to student talk, the language variety used and the teachers' and students' attitudes towards the medium of instruction in mathematics.

In determining the amounts of teacher talk and student talk, the 'utterance' was used as the unit of measure. Each utterance was classified as Filipino, English or the code-switching variety to determine the language variety used in the classroom. The subjects' responses to the survey questionnaire were analyzed to find out their attitudes towards the medium of instruction used in mathematics.

With respect to the nature of students' responses, these were analyzed in terms of their length and syntactic structure. The relationship between the level of the question and the students' response rate was tested for significance using the chi-square test.

Finally, the findings were scrutinized to see how they related to the improvement of pedagogy in mathematics. In the analysis of data, the cultural context of the Filipino learner was considered. For instance, the fact that the Filipino culture puts premium on shyness, timidity and respect for elders may explain why Filipino students very rarely ask questions or disagree with their teachers.

The method of research used was descriptive. Data were gathered using systematic classroom observation from two universities in Metro Manila, namely, Philippine Normal University and De la Salle University-Manila. These two were chosen to represent two kinds of learning institutions: a state university and a private school. The primary data gathering instruments were the tape recorder and the survey questionnaire. The teacher-participants consisted of one male and two female professors from each university. Each of them was audio-taped teaching two one-hour class sessions. No attempt was made to match the

teachers' professional qualifications and even the courses to be observed. In all, the data consisted of 11 hours of taped classroom interaction and 282 filled-out questionnaires. The taped verbal interactions were transcribed using ordinary Filipino and English orthography.

Significant findings of the study were as follows:

With respect to the teacher's questioning strategies, on the average, teachers asked 96.45 questions in one hour, of which about 73% were cognitive questions and 27% were socio-affective. Socio-affective questions refer to those questions that were not directly concerned with cognition but were directed toward carrying on class discussions. Forty-six percent (46%) of the cognitive questions asked were higher order questions, while 54% were lower order questions. The ratio of HOQ and LOQ in a class seemed to relate to the cognitive demand of the lesson - its difficulty level, and whether it was aimed at the introduction of new concepts (concept formation) or at consolidation and mastery of skills and concepts (review, drill, application).

Teachers used 26 questioning strategies in one class session. The more commonly used were repetition (10.54%), reformulation (7.91%), and redirection (3.09%). Less used were ignoring (2%), reinitiation (1.82%) and code-switching (1.09%). The amount of questioning strategies used by the teacher seemed to be largely determined by the teacher's personal style of communicating his/her thoughts.

Using the 'utterance' as the unit of analysis, the ratio of teacher talk (TT) to student talk (ST) in a tertiary mathematics classroom was 41:9, or 83% teacher talk and 17% student talk. For every utterance of the student, the teacher made 4.6 utterances.

The code-switching variety or Taglish was the preferred medium of instruction in teaching mathematics. About 84% of the subjects chose Taglish, while the remaining 16% opted for English. Not one of the subjects chose Filipino. The primary reason given by the subjects for choosing Taglish was that it improved their comprehension of the lesson.

The subjects who chose English as medium of instruction in mathematics cited two main reasons: (1) English can handle the demands of the mathematics register, a fact which cannot be said of the Filipino language; and (2) The world's mathematical and scientific knowledge can be accessed through English.

Surprisingly, despite this overwhelming preference for the use of Taglish in the classroom, English was the dominant language variety observed in both teacher talk and student talk. Specifically, about 77% of the class talk was in English, 15% in the code-switching variety or Taglish, and 8% in Filipino. This only goes to show that English still is the language of Science and Mathematics.

With respect to the nature of students' responses, the students recorded a total of 421 turns and 2,424 words. On the average, students got 38.27 turns of speaking, with each turn consisting of 5.96 words.

The study found that 92.84% of student responses were restricted and only 7.16% were elaborated. In terms of syntactic structure, 84.4% of the students' responses were in the word/phrase level. Only 8.18% of their responses used simple sentences and only 7.12% used complex/compound sentences.

On how students' response rate related to the cognitive level of the question, a total of 394 out of 772 (51.36%) cognitive questions asked by the teacher did not get a student response, while 378 (48.96%) got a student response. This implies that roughly, each question had a 50-50 chance of getting a student response. Statistically, a lower order question's chance of getting a student response compared to a higher order question's chance differed significantly at .01 level of significance. The computed value of 14.30 was greater than the chi-square critical value of 10.83.

Based on the findings of the study, the following conclusions were drawn:

1. The quantity and quality of students' language opportunities in the classroom were very limited. Their responses were highly restricted and were generally in the word/phrase level only.

2. The nature of students' responses was largely influenced by the kinds of questions the teacher asked and the classroom activities the teacher adopted. Factual and fill-in-the-blank questions usually got restricted replies, whereas requests for explanation and elaboration got elaborated replies.

3. The university mathematics teacher's style of teaching made use of the whole-class approach and was highly expository. This facilitated a more dominant teacher role in the classroom and a greater amount of teacher talk.

4. The teacher's pedagogical orientation seemed to influence to a great extent the following:

    a. the kinds of questions asked;
    b. the value placed on student participation;
    c. the quality and quantity of student responses; and
    d. the learning activities adopted.

    The cognitive demand of the lesson – its difficulty level and whether it was aimed at concept formation or the consolidation/mastery of skills and concepts – likewise appeared to relate to each of these areas.

5. Teachers used a combination of higher order and lower order questions of almost equal amounts. More higher order questions were asked when the subject matter was difficult and when the task dealt with concept formation as opposed to reviews, drills or practice exercises.

6. A question's cognitive level related to its chance of getting a student response. Lower order questions got a higher percentage of student response than higher order questions.

7. The teacher dominated class talk directed most, if not all, activities in the classroom. Basically, the student's function was to respond to the teacher's questions.

8. When students failed to answer the question, the teacher resorted to questioning strategies in this order of frequency: repetition, reformulation, redirection, ignoring, reinitiation and code-switching.

9. The code-switching variety or Taglish was the preferred language variety for conducting classroom discourse. Teachers and students were convinced that Taglish aided in comprehension.

10. None of the students and teachers believed that Filipino could replace English as the medium of instruction in Mathematics at this point.

11. English was the dominant language variety used in the mathematics class, followed by the code-switching variety and Filipino.

The relevance of a research is often measured in its usefulness. Instructional reforms for the teaching and learning of mathematics may be based on the following implications drawn from the study:

1. The pattern or sequence of moves that characterize the prevailing expository approach in teaching mathematics limits the language opportunities of the students since most, if not all, moves are teacher-directed. Instruction needs to be learner- rather than teacher-centered to encourage a more active student involvement in the learning process. Changing the sequence of moves in the teaching cycle could help towards this end.

2. Students lack skills in organizing their ideas. They need help in posing questions and in constructing arguments to prove their point. They need help in the process of explaining their solution to a certain problem.

3. Students need guidance and encouragement in the use of correct and precise mathematical language. To achieve this, the teacher should model the use of appropriate, specific and unambiguous terms and phrases in their teaching. For example, some mathematics teachers use the term 'equal' when they mean 'similar' or even 'congruent.'

4. Teachers need to improve their skills in providing feedback and in processing the answers of the students. They need to learn the art of drawing students' attention to the crucial aspects of a solution and of asking probing questions to help students clarify their own thinking.

5. The use of Taglish in the teaching of mathematics should not be discouraged since both students and teachers see it as helpful in making the message more comprehensible.

For language teachers, the findings of this study imply the following:

1. The need to train students in oral discourse, particularly in posing questions, in explaining a method or a solution, in building an argument, and in expressing their thoughts coherently; and

2. The need to work collaboratively with content teachers in developing among the students the communicative skills needed for educational success.

In the light of these findings and conclusions, it is my hope that we will be more sensitive to the quality of interaction that goes on in our classrooms, and that efforts will be taken by teachers of English to help mathematics teachers achieve this goal. For instance, language awareness seminars may be conducted to mathematics teachers on all levels towards this end.

Language specialists may also be invited to help content teachers use language appropriately and to the fullest to maximize students' learning. For instance, they could aid mathematics teachers in devising activities and strategies that would facilitate language learning in the mathematics classroom. These strategies would include journal writing, problem posing, and the use of portfolios, writing prompts and reflective journals, to name a few.

Let me end this paper with a quote from Durkin (1991). In describing the relationship between language and mathematics education, he said:

> Two of the essential ingredients of mathematics are people and communication....Mathematics education begins and proceeds in language, it advances and stumbles because of language, and its outcomes are often assessed in language.

REFERENCES

BACUNGAN, A. (1986). Discourse patterns in primary mathematics classes. Unpublished Ph.D. dissertation, University of the Philippines-Diliman.

BAUTISTA, M.L. (1987). Questioning-responding in Filipino and English: Classroom interaction in Philippine literature classes. *The DLSU Graduate Journal, 12*(1), 1-34.

BELUSO, O. (1989). An ethnography of interaction in two undergraduate literature classes at De La Salle University: Analysis of questioning and responding in the classroom. Unpublished D.A. dissertation, De la Salle University-Manila.

DE LA CRUZ , T. (1991). An analysis of questions asked by science teachers. Unpublished M.A. thesis, Philippine Normal College.

DURKIN, K. (1991). Language in mathematical education: An introduction. In K. Durkin & B. Shire (Eds.), *Language in mathematical education: Research and practice.* Great Britain.

FRENCH, P. & MACLURE, M. (1981). *Adult-child conversation.* London: Croomhelm Ltd.

GENUINO, C. (2000). Communicative opportunities in the tertiary second language classrooms: An analysis. Unpublished M. A. thesis, Philippine Normal University.

GREENES, C. & SCHULMAN, L. (1996). Communication processes in mathematical exploration and investigations. In P. Elliot and M. Kenney (Eds.), *Communications in mathematics: K-12 and beyond* (pp. 159-169). Reston, VA.: National Council of Teachers of Mathematics.

HASSARD, J. (2000). *Minds on science.* Atlanta, GA: Department MSIT, Georgia State University. Available at http://scied.gsu.edu/Hassard/mos/mos.html.

INDUCTIVO, M.B. (1994). Code-switching as a communication strategy in science: Effects on pupils' achievement, attitude and class participation. Unpublished M.A. thesis, University of the Philippines-Diliman.

INOCENCIO, O. (1992). Questioning and responding in high school science classes: A classroom interaction analysis. Unpublished D.A. dissertation, De La Salle University-Manila.

KHISTY, L. (1994). A naturalistic look at language factors in mathematics teaching in bilingual classrooms. Paper presented at the Third National Research Symposium on Limited English Proficient Student Issues: Focus on middle & high school issues. In A. Orton and G. Wain (Eds.), *Issues in teaching mathematics*. Great Britain: Cassell Villiers House. Available at **http://www.ncbe.gwu.edu/ncbepubs/symposia/third/khisty.html**.

NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS. (1991). *Professional standards for teaching mathematics.* Reston: V.A.: The Council.

ORTON, A. & WAIN, G. (Eds.) (1994). *Issues in teaching mathematics.* Great Britain: Cassell Villiers House.

PENAFLORIDA, A. (1986). Teacher talk and student talk in college freshmen science laboratory classes. Unpublished Ph. D. dissertation, University of Santo Tomas.

SANTOS, T. (1984). Classroom language use in selected public elementary schools of Region III. Unpublished Ph.D. dissertation, De la Salle University-Manila.

TARONE, E. (1983). Some thoughts on the notions of 'communication' strategy.' In C. Faerch and G. Kasper (Eds.), *Strategies in interlanguage communication.* London: Longman.

THE INTERNATIONAL COMMISSION ON MATHEMATICS INSTRUCTION (ICMI). (1997). *On the teaching and learning of mathematics at university level.* Bulletin No. 43. Available at http://elib.zib.de/IMU/ICMI/bulletin/43/study.html