US-China Education Review A 7 (2012) 639-649
Earlier title: US-China Education Review, ISSN 1548-6613

Reporting Qualitative Data Quantitatively: Code-Switching in Mathematics Classrooms

Kian-Sen Neo, Buai-Chin Heng
UiTM (Universiti Teknologi MARA), Shah Alam, Malaysia

This article is based on a research investigating the communication in primary mathematics classrooms. One of the research's objectives was to determine what languages were used in the primary mathematics classrooms, and to what extent, do teachers and students resort to code-switching in teaching and learning mathematics. A total of 16 classroom mathematics lessons from primary schools in the Kelantan State of Malaysia were observed and recorded. Within the four schools, two were SK (national schools) and two were SJKC (Chinese primary schools). A rural school and an urban school constituted the two schools of the same type. The researcher observed four classes from two levels for each participating school, i.e., two Standard 2 classes from the lower primary level and two Standard 5 classes from the upper primary level. The two classes of each level were in fact comprised of a good class and a weak class. The use of languages in resorting to code-switching was examined across various factors, such as types of schools, school location, class levels, and types of classes. The notion of C-unit (communicative unit) proposed by Loban (1976) was used to analyze the types of languages use as well as their proportion of use. This article shows that by using C-unit as the unit of analysis, the qualitative data gathered from the classroom discourse can well be reported quantitatively in terms of the proportion of students' L1 (first language), L2 (second language), and code-mixing of L1 and L2 in response to various factors.

Keywords: quantitative, qualitative, mathematics classrooms, code-switching

Introduction

In Malaysia, with the implementation of Teaching and Learning of Science and Mathematics in English or better known in Malay as or PPSMI (Pengajaran dan Pembelajaran Sains dan Matematik dalam Bahasa Inggeris) began from 2003, the medium of instruction of mathematics and science in national primary schools and Tamil primary schools is English, a language which is not the mother tongue of the majority of the students in the respective schools[1]. In SJKC (Chinese primary schools), mathematics and science are taught in two languages, i.e., Mandarin and English. Although Malaysian teachers comply with the official language policy for the teaching of mathematics and science, the students' first languages (Malay, Chinese, and Tamil) are still used, leading to the phenomenon of code-switching in the classrooms. Code-switching refers to the use of more than one language within a turn or utterance in interaction among bi-/multi- linguals, both in in-group and out-group encounters. David (2003) reported that code-switching was used by Malaysians as a resource, a tool,

Kian-Sen Neo, Ed.D., senior lecturer, Academy of Language Study, UiTM (Universiti Teknologi MARA).
Buai-Chin Heng, M.Ed., senior lecturer, Academy of Language Study, UiTM (Universiti Teknologi MARA).

[1] This new policy of medium of instruction in mathematics and science has recently been reverted to the original language of instruction, i.e., Bahasa Malaysia from January, 2011 at Standard 1 of primary school.

and a strategy of communication. She concluded that the functions of code-switching in several empirical researches are to soften a directive, emphasize a point, help communication, indicate regional allegiance, show power, and status and construct meaning when one needs to compensate for a limited vocabulary.

Problem Statement and Objective of the Study

Recent available research in Malaysia concerning classroom practices in relation to the implementation of PPSMI has found that code-switching is a common feature in most classrooms (Sidhu, 2005). In the classroom context, school teachers and pupils are used to the switching between students' mother tongue and the language of instruction for a range of managerial, affective, and cognitive development purposes (Cook, 2001). So far, research examining the practice of code-switching in primary mathematics classrooms remains limited. Thus, it is crucial to understand how bilingual teachers and students utilize their facility with two languages to communicate mathematically within the primary classrooms. To examine the above issue, this article proposes an approach in reporting quantitatively on a set of qualitative data gathered from mathematics classroom discourse. The research's objective was to identify what languages and their extent of use in bilingual primary mathematics classroom and to examine whether the practice of code-switching of mathematics teachers varies across types of school, school location, levels, and types of class.

Participants

Sixteen classes from two types of primary schools from the Kelantan state participated in this study. Of the 16 classes, eight were from two SK (national schools) and the other eight were from two SJKC. A rural school and an urban school constituted the two schools of the same type. Within the four classrooms of each school, two were Standard 2 and the other two were Standard 5. Again, within two classes from a level, one was a good class and the other was a weak class. The participating sample was chosen according to the above traits due to the consideration investigating whether the pattern of language use varied across the types of school, school locations, class levels, and student's performing level which was identified as "good class" and "weak class".

Methods of Data Collection and Analysis

This study employed two methods for data collection, i.e., classroom observation and interview. However, for this article, only the method of classroom observation and the methods of data analysis related to classroom observation are discussed. The method of observation was employed, because this method enabled the researcher to see and hear directly the natural language used and interaction of the participants in mathematics classrooms. The teaching of mathematics in 16 classes was observed and video-recorded. The duration of each observed class varied from half an hour to an hour. To prevent information lost, it was also used a voice recorder to record every classroom discourse. All video-recorded and audio-recorded data were transcribed verbatim.

Unit of Analysis

This study focused on the teachers' bilingual utterances, especially the moment and the way they used code-switching for cognitive, conversational, affective, social, and managerial purposes. Thus, the unit of analysis is the smallest meaningful utterance unit in a stretch of discourse. Such unit was first named by Loban (1976) as C-unit (communicative unit). In this study, the definition of "an utterance of C-unit" is the short expression in spoken language segmented naturally by a longer pause or turn of speech, but has a pragmatic or

referential meaning. Since this study was studying the types and purposes of the language used in spoken discourse, this implies that the present study was concerned more on meaning rather than the grammatical structure of a discourse. Therefore, the researcher accepted all the possible sentences, clauses, phrases, and words that constitute an utterance with a communicative value as C-units, whether it is grammatical or not. For instance, in the present research data, the elliptical answer of a student to an over-simplified question asked by a teacher shown below contains fragmented sentences, but they are two utterances of C-unit:

> Q: What shape (= What is the shape of this figure? With the aid of an extra-linguistic act, i.e., a figure of a square shape was pointed by the teacher.)?
> A: Square (= It is a square.).

Languages Used in an Utterance of C-Unit

After the discursive data in the transcripts were segmented into utterances of C-units grounded on the syntactic and semantic criteria, the types of language used in each utterance were investigated and determined in terms of L1 (first language), such as Malay or Chinese, L2 (second language), i.e., English, and the code -mixing of L1 and L2. Hereinafter, L1 refers to the students' mother tongue and L2 refers to English.

For the purpose of quantitative analysis, the four varieties of language used in SK are represented by the symbols "M", "M ⊂ E", "E ⊂ M", and "E" which stand for "purely Malay units", "Malay embedded in English units", "English embedded in Malay units", and "purely English units". While two languages are mixed in an utterance and one is the dominant, "M ⊂ E" means English is the matrix (or major/base) language (Myers-Scotton, 1993, p. 3), Malay is the embedded (or minor/guest) language; and conversely, "E ⊂ M" means Malay is the matrix language, English is the embedded language. For example, "E ⊂ M" utterance is that "siapa faham time (who knows time)"? On the other hand, for example, "M ⊂ E" utterance is "clock ada two hands (clock has two hands)". In SJKC, the four types of language variety that parallel to its counterpart in SK "M, M ⊂ E, E ⊂ M, and E" are: "C, C ⊂ E, E ⊂ C, and E" stand for "purely Chinese units", "Chinese embedded in English units", "English embedded in Chinese units", and "purely English units". Many criteria have been proposed for determining matrix language (Hamers & Blanc, 2000, p. 260). This study adopts the statistical criteria that the "language with the higher frequency of words" in the sentence is the base language.

Estimation of the Use of L1 in Classroom Discourse

The ratio of L2 to L1 used in classroom discourse was calculated for both SK and SJKC discursive data. That is, in SK, the "ratio of English to Malay words used in classroom discourse" was calculated; and in SJKC, the "ratio of English to Chinese words used in classroom discourse" was calculated. They were calculated in terms of "100:*x*". In SK, the figure "100:34.43" means "for every 100 English words in use, there are 34.43 Malay words". In the calculation of "100:*x*", the video transcripts were first cleaned up by removing the notations for speakers (e.g., T, S, SS which stand for teacher, student, students), description of speech acts and classroom activities (e.g., pause, laugh, student has no response, computer-aided instruction is on, teacher demonstrates the state of a container that is half full), so that it remained only the verbal utterances in terms of L1 and L2 of teacher and students.

The procedure for calculation of "100:*x*" is explained as follows. The researcher sought help from the Window 97 program for estimation of total words of each language type which appeared in a transcript. Take transcript of T5 (Teacher 5) in Table 1 as an example for explanation. There are 218 utterances gathered

from a lesson of 26 minutes of recording. The calculation of words in 218 utterances in the transcript produced altogether 915 words. Later, all L2 (English) words were deleted, leaving only the L1 (Malay) words. The Window 97 program was once more used for the calculation of L1 words, listing 328 Malay words. Hence, the number of English words is 915 – 328 = 587. The ratio of English: Malay is 587:328. Then, dividing both side by 5.87 (the number that turns 587 into 100), it is "100:55.88". This implies that the use of the L1 in classroom discourse of T5 is (55.88 ÷ 155.88) × 100% = 35.85%. Actually, the percentage for coverage of "b" in a:b is (b ÷ (a + b)) × 100%, hence, the value 35.85% can also be given by (328÷ (587 + 328)) × 100%.

Table 1

Language Use of Eight Classes in SK

Teacher (Lesson duration)	L1, L2, and code-mixing of L1 and L2					100:*x* = Ratio of L2 to L1
	E	M ⊂ E	E ⊂ M	M	Total	
T1	421	23	34	85	563	**100:34.43
(*35:21)	74.8%	4.1%	6.0%	15.1%		(25.61% use of L1)
T2	311	6	1	1	319	100:0.91
(33:10)	97.5%	1.9%	0.3%	0.3%		(0.9% use of L1)
T3	216	10	76	169	471	100:94.40
(59:12)	45.9%	2.1%	16.1%	35.9%		(48.56% use of L1)
T4	489	12	16	109	626	100:30.07
(1:20:01)	78.1%	1.9%	2.6%	17.4%		(23.12% use of L1)
T5	120	13	10	75	218	100:55.88
(26:00)	55.0%	6.0%	4.6%	34.4%		(35.85% use of L1)
T6	357	26	38	410	831	100:159.88
(59:11)	43.0%	3.1%	4.6%	49.3%		(61.52% use of L1)
T7	660	5	5	69	739	100:19.03
(58:07)	89.3%	0.7%	0.7%	9.3%		(15.99% use of L1)
T8	557	46	86	358	1,047	100:108.25
(57:06)	53.2%	4.4%	8.2%	34.2%		(51.98% use of L1)
Total	3,131	141	266	1,276	4,814	100:58.25
(6:48:08)	65.0%	2.9%	5.6%	26.5%		(36.81% use of L1)

Notes. *35:21 means 35 minutes 21 seconds; 6:48:08 means 6 hours 48 minutes 8 seconds; **100:34.43 means for every 100 English words in use, there are 34.43 Malay words.

To estimate the mean value for the rate of the use of L1 in all the classroom discourse in the sample school, the total number of utterances in each class was taken as the weight for calculation of weighted mean. For instance, with reference to Table 1, the weighted mean for the use of L1 in mathematics classrooms of SK is (563 × 25.61 + 319 × 0.9 + 471 × 48.56 + … + 1047 × 51.98) ÷ 4814 = 36.81. Next, the value of *x* in 100:*x* that corresponding to 36.81% (i.e., 0.3681) is given by *x* = 100(0.3681) ÷ (1 – 0.3681) = 58.25. For other instances, the weighted mean is calculated by the formula $\frac{\sum_{i=1}^{n} w_i x_i}{\sum_{i=1}^{n} w_i}$, where w_i is the weight and x_i is the percent of coverage of the use of L1 in mathematics classrooms.

Types of Code-Switching and Counting of Cases

Initially, the researcher, using Poplack's (1980) three-way divisions identified three types of codes witching from the structural perspective. They are tag-switching, intra-sentential code-switching and inter-sentential code-switching. Tag-switching refers to insertion of a tag or interjection in language A into an utterance which is otherwise entirely in language B (e.g., "you know", "look", "I mean", etc.). Intra-sentential code-switching involves all kinds of switchings within the clause or sentence boundary. Inter-sentential

code-switching involves a switch at a clause or sentence boundary, where each clause or sentence is in one language or another. All three types of code-switching may be found within the same discourse. However, because the unit of analysis of Poplack is sentence and the unit of analysis of this study is utterance, this way of identifying the unit of analysis has turned the categorization of tag switching into a problem. Based on the definition of the C-unit, a short utterance inserted into a long sentence can sometimes be counted as a C-unit and sometimes just serves as part of the words in a C-unit. As a result, this research mainly used the C-unit as the unit of analysis and resolved all the sentences under the initial categorization of tag-switching into intra-sentential code-switching and inter-sentential code-switching.

In this study, many examples of "tag switching" are insertions of habitual use of language in the students' L1 by a particular teacher at the end of a stretch of L2 (English), while giving examples, explanation or instruction, such as "apa dia (what's that)", "faham (understand)", or "Lagi (any more)". An example of such use is shown below:

T: Unit of volume (...) apa dia? (Type M ⊂ E) < utterance 22 of T2 >

Regarding the category of tag switching, some researchers argued that it should actually be subsumed under the intra-sentential code-switching and should not be set as one structural category juxtaposed with intra-sentential code-switching and inter-sentential code-switching (Huang, 2006, p. 30; Bentahila & Davies, 1995; Huang & Milroy, 1995; Myers-Scotton, 2002). Among them, Huang (2006, p. 30) maintained that resolving tag-switching into intra-sentential code-switching "can avoid inconsistency of the categorization criterion of three-way divisions of Poplack".

A review by Cook (2001) reported that 84% of the utterances in the bilingual conversation was intra-sentential code-switching, 10% was inter-sentential code-switching and only 6% was tag-switching. This shows that the occurrence of tag-switching in the bilingual conversation is relatively small on many of the language sites compared with the other two types of code-switching. As the number of the instances of "tag-switching" was relatively small, in this study, the researcher considered cases of tag-switching as negligible and decided to resolve this category into intra-sentential code-switching or inter-sentential code-switching, i.e., some were counted as the "intra-sentential code-switching" and some were counted as the "inter-sentential code-switching" depending on how they satisfied the criterion of a C-unit and the way they were inserted/uttered by a particular teacher.

The calculation of the number of instances of intra-sentential code-switching was based on the total number of the utterances of "L1 ⊂ L2" and "L2 ⊂ L1". For example, in Table 2, it was based on the total number of the utterances of "M ⊂ E" and "E ⊂ M". On the other hand, the calculation of the number of instances of inter-sentential code-switching was counted based on the number of shifts between "E" and "M" in the cluster of utterances formed by "E" and "M" only. Take the discursive data of SK as an example, the shifts of utterances from "M ⊂ E" to "E" (and vice versa) and "E ⊂ M" to "M" (and vice versa) were excluded for calculation of the number of instances of inter-sentential code-switching. For instance, utterances appearing in the "M ⊂ E, E, M, E ⊂ M, M, E" and "E, M, E" sequence were both counted as two incidences of inter-sentential code-switching by cleaning up all utterances of "M ⊂ E" and "E ⊂ M" in the sequence. Then, the former, "-, E, M, -, M, E", was left with only two clusters of "E" and "M". Each cluster had only one shift; therefore, the total was two.

Table 2

Cases of Inter-sentential and Intra-sentential Code-Switching by Teachers and Students in Eight Mathematics Classrooms in SK

Teacher (Gender, class, years of teaching)	Total utterances produced in class	Code-switching		Total cases of code-switching
		Inter-sentential	Intra-sentential (M ⊂ E and E ⊂ M)	
T1 (F, U5G, 8)	563	57 10.1%	57 10.1%	114 20.2%
T2 (F, U5W, 25)	319	2 0.6%	7 2.2%	9 2.8%
T3 (F, U2G, 15)	471	55 11.7%	86 18.2%	141 29.9%
T4 (F, U2W, 8)	626	78 12.5%	28 4.5%	106 16.9%
T5 (M, R5G, 14)	218	41 18.8%	23 10.6%	64 29.4%
T6 (M, R5W, 21)	831	201 24.1%	64 7.7%	265 31.8%
T7 (F, R2G, 14)	739	60 8.1%	10 1.4%	70 9.4%
T8 (F, R2W, 13)	1,047	187 17.9%	132 12.6%	319 30.4%
Total	4,814	681 14.1% (62.6%)	407 8.5% (37.4%)	1088 22.6% (100%)

Notes. F: female; M: male; U: urban school; R: rural school; 5: Standard 5; 2: Standard 2; G: good class; and W: weak class, respectively.

Findings and Discussion

Table 3

Language Use of Eight classes in SJKC

Teacher (Lesson duration)	L1, L2, and code-mixing of L1 and L2					100:*x* = Ratio of L2 to L1
	E	C ⊂ E	E ⊂ C	C	Total	
T9 (1:14:22)	612 56.8%	22 2.0%	120 11.2%	323 30.0%	1,077	100:70.46 (41.33% use of L1)
T10 (40:04)	249 44.5%	20 3.6%	35 6.3%	255 45.6%	559	100:58.4 (36.87% use of L1)
T11 (50:28)	227 63.1%	7 1.9%	22 6.1%	104 28.9%	360	100:98.1 (49.52% use of L1)
T12 (56:04)	484 60.6%	41 5.1%	86 10.8%	188 23.5%	799	100:64.37 (39.16% use of L1)
T13 (1:14:51)	698 99.4%	0 0%	0 0%	4 0.6%	702	100:0.5 (0.5% use of L1)
T14 (34:54)	325 81.7%	2 0.5%	30 7.5%	41 10.3%	398	100:24.76 (19.84% use of L1)
T15 (28:25)	155 88.6%	2 1.1%	1 0.6%	17 9.7%	175	100:7.3 (6.80% use of L1)
T16 (55:57)	80 17.3%	20 4.3%	95 20.5%	268 57.9%	463	100:246.99 (72.06% use of L1)
Total (6:55:5)	2830 62.4%	114 2.5%	389 8.6%	1200 26.5%	4533	100:53.00 (34.64% use of L1)

By using the methods same as above, the languages used in SJKC in terms of L1 (Chinese), L2 (English) and the code-mixing of L1 and L2 are shown in Table 3 and Table 4 as follows. Besides carrying the mark of

types of language(s) used, each utterance carries also the marks of types of school (SK *vs.* SJKC), school location (urban *vs.* rural), class level (Standard 2 *vs.* Standard 5), and types of class (good *vs.* weak). By resolving the individual information given in Tables 1 to 4 and putting it into new groups according to factors, it is been able to check the extent of the use of code-switching across various factors, such as types of school, location of school, class level, and types of class. Tables 5 to 12 reveal the result of comparison of the extent of resorting of code-switching across various factors.

Table 4

Cases of Inter-sentential and Intra-sentential Code-Switching by Teachers and Students in Eight Mathematics Classrooms in SJKC

Teacher (Gender, class, years of teaching)	Total utterances produced in class	Code-switching		Total cases of code-switching
		Inter-sentential	Intra-sentential (C ⊂ E and E ⊂ C)	
T9 (F, U5G, 20)	1,077	59 5.5%	142 14.2%	201 18.7%
T10 (F, U5W, 6)	559	61 10.9%	55 9.9%	116 20.8%
T11 (F, U2G, 32)	360	61 16.9%	29 8.0%	90 24.9%
T12 (F, U2W, 4)	799	127 15.9%	127 15.9%	254 31.8%
T13 (F, R5G, 20)	702	8 1.1%	0 0%	8 1.1%
T14 (F, R5W, 13)	398	38 9.5%	32 8.0%	70 17.5%
T15 (F, R2G, 8)	175	27 15.4%	3 1.7%	30 17.1%
T16 (F, R2W, 2)	463	57 12.3%	115 24.8%	172 37.1%
Total	4,533	438 9.7% (46.5%)	503 11.1% (53.5%)	941 20.8% (100%)

Notes. F: female; M: male; U: urban school; R: rural school; 5: Standard 5; 2: Standard 2; G: good class; and W: weak class, respectively.

Comparison of the Use of L1, L2, the Code-Mixing of L1 and L2 Between Two Types of School

As shown in Tables 5 and 6, the merging of all the utterances in two types of schools generated a total of 13 hours 43 minutes 13 seconds of video recording, which produced a total of 9,347 utterances. Among them, 63.8% of the utterances were in the formal medium of instruction, L2 (English), 26.5% of the utterances used the students' mother tongue, Malay or L1 (Chinese) to teach mathematics, and the rest 9.7% of the utterances had intra-sentential code-switching, which was either in the form of L1 ⊂ L2 or L2 ⊂ L1. Overall, 35.76% of classroom discourse in primary mathematics classroom used the students' L1. This implies that 64.24% of the total classroom discourse comprised of English words. This figure is closely similar to 63.8% of the total use of pure English utterances. The concurrence of these two figures in turn enhances the reliability of the calculation method proposed in this article for estimation of the extent of types of language use in classroom discourse.

In Table 5, teachers from both types of school resorted to using the students' L1 in 36.81% and 34.64% of the utterances, showing only a little difference (2.17%). Besides, when the effects of all factors in individual classrooms were countered one by the other, the code-switching practices between two types of schools were

surprisingly similar in terms of the percentage of coverage of types of language used (L2, L1 ⊂ L2, L2 ⊂ L1, and L1), as shown in Table 5. They are 65.0%, 2.9%, 5.6%, and 26.5% in SK against 62.4%, 2.5%, 8.6%, and 26.5% in SJKC. The differences between the two were 2.6%, 0.4%, -3%, 0% which sum up as 5% as far as their magnitude is concerned. The fine difference is seen among Chinese mathematics teachers, who tend to resort to intra-sentential code-switching (E ⊂ C) instead of inter-sentential code-switching, unlike the SK mathematics teachers' practices. One interesting finding in the data of SJKC in Table 5 was that between C ⊂ E and E ⊂ C, the use of E ⊂ C is 3.5 times higher than that of C ⊂ E (The incidence of E ⊂ M is higher between M ⊂ E and E ⊂ M at SK). When instances of inter-sentential and intra-sentential code-switching are examined in two types of school, the frequency of mathematics teachers of SJKC resorting to the latter is moderately higher (2.6% higher). In the Malaysian context, it is a very common experience to hear a Malaysian Chinese inserting one or two English words in their daily utterances, even when Chinese serves as the matrix language of the utterance. This may be due to Malaysia's status as a former British colony. Such phenomenon of code-switching among the Chinese is also found in other formal colonial states of Britain like Singapore and Hong Kong (Huang, 2004; Lin & Martin, 2005; Marasigan, 1983; Yau, 1993).

Table 5

Comparison of the Use of L1, L2, the Code-Mixing of L1 and L2 Between Two Types of School

Types of school (Number of classes)	L1, L2 and code-mixing of L1 and L2					100:*x* = Ratio of L1 to L2
	E	M ⊂ E/(C ⊂ E)	E ⊂ M/(E ⊂ C)	M/(C)	Total	
SK	3,131	141	266	1,276	4,814	100:58.25
(8)	65.0%	2.9%	5.6%	26.5%		(36.81% use of L1)
SJKC	2,830	114	389	1,200	4,533	100:53.00
(8)	62.4%	2.5%	8.6%	26.5%		(34.64% use of L1)
Total	5,961	255	655	2,476	9,347	100:55.67
(16)	63.8%	2.7%	7.0%	26.5%		(35.76% use of L1)

Table 6

Comparison of the Use of Inter-sentential and Intra-sentential Code-Switching Between Two Types of School

Types of schools (Number of classes)	Total of lesson duration	Code-switching		Total cases of code-switching
		Inter-sentential	Intra-sentential	
SK	6:48:08	681	407	1,088
(8)		14.1%	8.5%	22.6%
SJKC	6:55:05	438	503	941
(8)		9.7%	11.1%	20.8%
Total	13:43:13	1,119	910	2,029
(16)		12.0%	9.7%	21.7%

Comparison of the Use of L1, L2, the Code-Mixing of L1 and L2 Between Urban and Rural Schools

Generally, the extent of the use of code-switching between the urban and rural schools is quite identical as shown in Tables 7 and 8.

Comparison of the Use of L1, L2, the Code-Mixing of L1 and L2 Between Two Class Levels

Table 9 and Table 10 show the comparison of the use of L1, L2, the code-mixing of L1 and L2 between two class levels, i.e., Standard 5 and Standard 2. It is obviously shown in the data that teachers who teach in lower primary level resort more to students' mother tongue in mathematics teaching. In Table 9, the classroom discourse in Standard 2 consists of 40.01% use of L1, whereas in Standard 5, it is only 31.50%. Similarly, as

shown in Table 10, the difference of the use of inter-sentential as well as intra-sentential code-switching between the two levels is 25.2% – 18.1% = 7.1%. Similarly, this phenomenon implies that primary mathematics teachers are aware of the English proficiency level of their younger students that still need extra use of L1 to communicate mathematically.

Table 7

Comparison of the Use of L1, L2, the Code-Mixing of L1 and L2 Between Urban and Rural Schools

Location of schools (Number of classes)	L1, L2 and code mixing of L1 and L2					100:*x* = Ratio of L1 to L2
	E	M ⊂ E/(C⊂E)	E ⊂ M/(E ⊂ C)	M/(C)	Total	
Urban	3,009	141	390	1,234	4,774	100:55.44
(8)	63.0%	3.0%	8.2%	25.8%		(34.83% use of L1)
Rural	2,952	114	265	1,242	4,573	100:58.05
(8)	64.6%	2.5%	5.8%	27.2%		(36.73% use of L1)
Total	5,961	255	655	2,476	9,347	100:55.67
(16)	63.8%	2.7%	7.0%	26.5%		(35.76% use of L1)

Table 8

Comparison of the Use of Inter-sentential and Intra-sentential Code-Switching Between Urban and Rural Schools

Location of schools (Number of classes)	Total of lesson duration	Code-switching		Total cases of code-switching
		Inter-sentential	Intra-sentential	
Urban	7:08:42	500	531	1,031
(8)		10.5%	11.1%	21.6%
Rural	6:34:31	619	379	998
(8)		13.5%	8.3%	21.8%
Total	13:43:13	1,119	910	2,029
(16)		12.0%	9.7%	21.7%

Table 9

Comparison of the Use of L1, L2, the Code-Mixing of L1 and L2 Between Two Class Levels

Class level (Number of classes)	L1, L2 & code-mixing of L1 and L2					100:*x* = Ratio of L1 to L2
	E	M ⊂ E/(C ⊂ E)	E ⊂ M/ (E ⊂ C)	M/(C)	Total	
Standard 5	3,093	112	268	1,194	4,667	100:45.98
(8)	66.3%	2.4%	5.7%	25.6%		(31.50% use of L1)
Standard 2	2,868	143	387	1,282	4,680	100:66.69
(8)	61.3%	3.0%	8.3%	27.4%		(40.01% use of L1)
Total	5,961	255	655	2,476	9,347	100:55.67
(16)	63.8%	2.7%	7.0%	26.5%		(35.76% use of L1)

Table 10

Comparison of the Use of Inter-sentential and Intra-sentential Code-Switching Between Two Class Levels

Class level (Number of classes)	Total of lesson duration	Code-switching		Total cases of code-switching
		Inter-sentential	Intra-sentential	
Standard 5	6:17:53	467	380	847
(8)		10.0%	8.1%	18.1%
Standard 2	7:25:20	652	530	1,182
(8)		13.9%	11.3%	25.2%
Total	13:43:13	1,119	910	2,029
(16)		12.0%	9.7%	21.7%

Comparison of the Use of L1, L2, the Code-Mixing of L1 and L2 Between Good and Weak Classes

The "good" and "weak" classes were identified by the participating schools. Data from Table 11 and Table 12 reveal that teachers who teach the weak students tend to resort more on students' L1. Such scene is supported by the fact of the difference of percentage use of L1 in the classroom discourse between the good and the weak classes: 42.34% – 28.06% = 14.28%. The total use of code-switching was also very high in the weak classes, i.e., 26.0%, which is 4.3% above the average level of 21.7%.

Table 11

Comparison of the Use of L1, L2, the Code-Mixing of L1 and L2 Between Good Class and Weak Class

Types of classes (Number of classes)	L1, L2 and code-mixing of L1 and L2					100:*x* = Ratio of L1 to L2
	E	M ⊂ E/(C ⊂ E)	E ⊂ M/(E ⊂ C)	M/ (C)	Total	
Good (8)	3,109 72.3%	82 1.9%	268 6.2%	846 19.6%	4,305	100:39.00 (28.06% use of L1)
Weak (8)	2,852 56.6%	173 3.4%	387 7.7%	1,630 32.3%	5,042	100:73.43 (42.34% use of L1)
Total (16)	5,961 63.8%	255 2.7%	655 7.0%	2,476 26.5%	9,347	100:55.67 (35.76% use of L1)

Table 12

Comparison of the Use of Inter-sentential and Intra-sentential Code-Switching Between Good Class and Weak Class

Types of classes (Number of classes)	Total of lesson duration	Code-switching		Total cases of code-switching
		Inter- sentential	Intra-sentential	
Good (8)	6:46:46	368 8.5%	350 8.1%	718 16.6%
Weak (8)	6:56:27	751 14.9%	560 11.1%	1,311 26.0%
Total (16)	13:43:13	1,119 12.0%	910 9.7%	2,029 21.7%

Conclusions and Recommendations

After examining the extent of the use of code-switching across the four factors, it can be concluded that the types of classes (good *vs.* weak) and the level of classes (Standard 5 *vs.* Standard 2) are two important factors that would be considered by the school mathematics teachers, while resorting to students L1 in mathematics teaching. The other two factors, i.e., the types of school and the location of school may not play an important role in determining the extent of the use of L1 in mathematics classroom discourse. However, as the sample size of the study is small, the above finding is not robust enough for a grounded generalization. It is recommended by the researcher that one can try to apply the above analysis technique to identify and examine the extent of types of language used in classroom discourse for other subject content areas, as the quantitative approach proposed in this article in reporting the qualitative data on mathematics classroom discourse, particularly, for identifying and examining the use of languages, is found useful and reliable. The approach does not need to advance statistical and qualitative data analysis package. One can resort to Window 97 and the like to perform the data analysis.

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