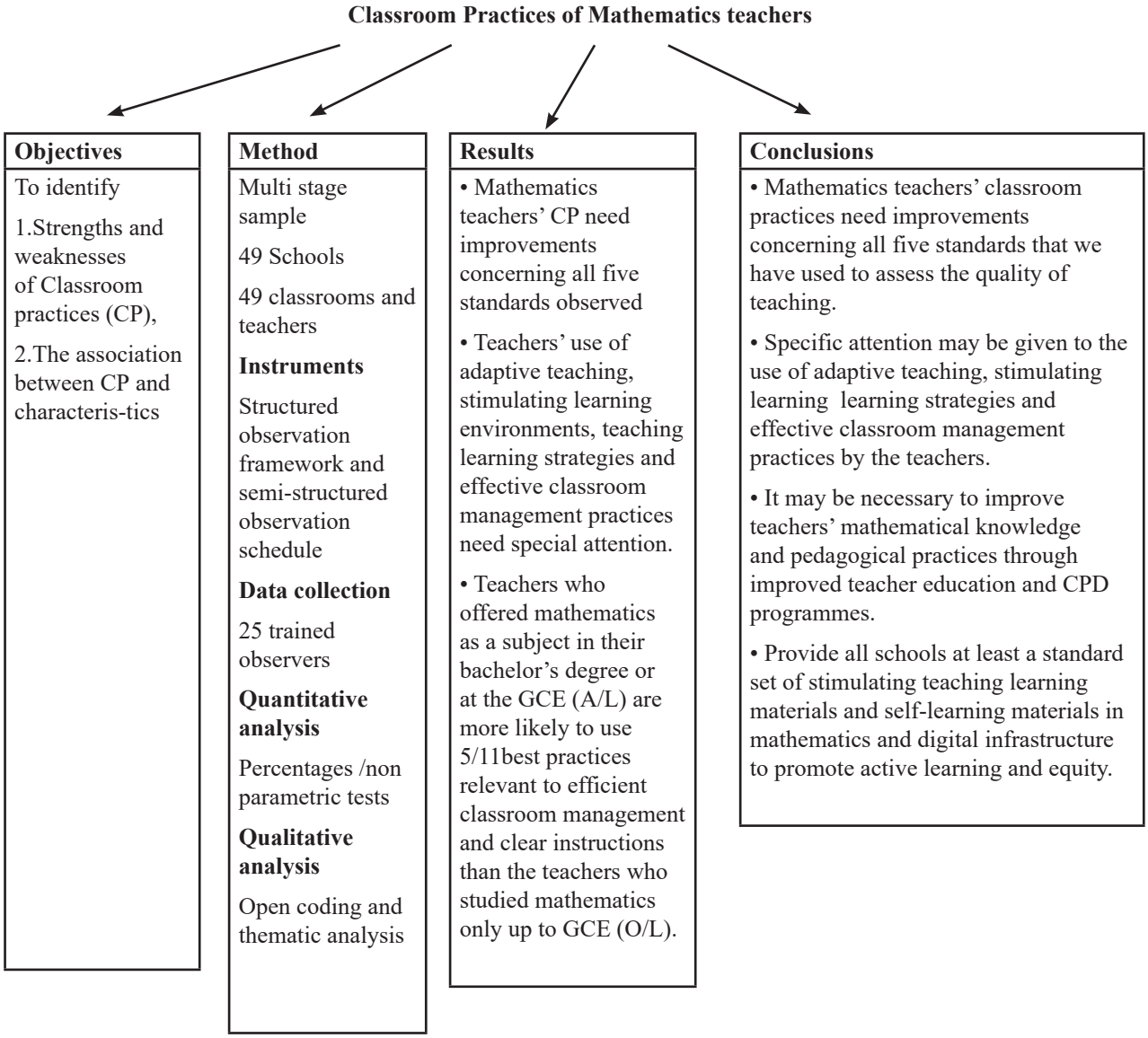
RESEARCH ARTICLE

Mathematics teachers' classroom practices: an observational study conducted in the Central Province of Sri Lanka

S.D.K. Wijesundera*, W.M.S.G.D.C. Wanigasekara and K.S.H.M.V.W.W. Senevirathne



Research Highlights

- Improve adaptive teaching, stimulating learning environments and teaching-learning strategies
- Classroom practices are associated with teachers' highest qualification in mathematics
- Limited opportunities for students to interact with each other in cooperative learning and group activities
- Improve the use of scaffolding and real-life problem solving to teach students advanced cognitive strategies
- Four pronged approach is necessary to improve the quality of teaching and student learning.

Ceylon Journal of Science 51(4) 2022: 419-429
DOI: http://doi.org/10.4038/cjs.v51i4.8059

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Received: 25/01/2022; Accepted:03/11/2022

Abstract: The current study explored the strengths and weaknesses of classroom practices of mathematics teachers and the association between those practices with selected teacher characteristics. Observational data collected from a sample of 49 Grade 7 mathematics lessons in 49 schools relating to 49 teachers in the Central Province of Sri Lanka were analysed using quantitative and qualitative methods. The analysis of quantitative data revealed that teachers' classroom practices related to all five standards considered in the study need improvement while specific attention is necessary for improving adaptive teaching, stimulating learning environments and teaching-learning strategies. Qualitative data also supported the above findings and provided further insights into strengths and weaknesses of mathematics teachers' classroom practices. Teachers' classroom practices relevant to all five standards are independent of their gender, medium of instruction, and professional qualifications. However, Teachers who offered mathematics as a subject in their bachelor's degree programme or at the GCE (A/L) were more likely to use a few of the best practices relevant to the standards of effective classroom management and clear instructions than the teachers who studied mathematics only up to GCE (O/L). Implications of these findings are discussed and suggestions for improvement of mathematics teachers' classroom practices are presented.

Keywords: Classroom Practice; Teaching and Learning; Secondary Mathematics; Classroom Management; Learning Environment .

INTRODUCTION

Mathematics is essential in decision making in day-to-day life, the world of work and society. Schoenfeld (2002) postulates "to fail children in mathematics, or to let mathematics fail them, is to close off an important means of access to society's resources". Therefore, improving the quality of mathematics teaching and learning should be a priority in the agenda for ensuring equity in education. The National assessment (National Education Research Centre (NEREC), 2017) indicates that there is a problem of low achievements among Grade 8 students in Sri Lanka and there are disparities with gender, medium of instruction, type of school and province. It analyses these disparities in detail, but it did not adequately explain the reasons behind those disparities. Research indicates that students' socio-economic status, their motivations, intellectual capacities, disabilities, parental and family support, school climate factors, teachers and their classroom practices affect student learning and achievements in mathematics (Schoenfeld, 2002; Wenglinsky, 2003). In this study, we decided to focus on mathematics teachers' classroom practices. The aim of the study is to investigate the strengths and weaknesses of classroom practices of mathematics teachers and the associations between selected teacher characteristics and their classroom practices at junior secondary level of education in the Central Province of Sri Lanka.

To achieve the above aim, the following research questions have been formulated;

1. What are the strengths and weaknesses of mathematics teachers' classroom practices at the junior secondary level?
2. Do the teachers' classroom practices associate with teacher characteristics such as gender, ethnicity, highest qualifications in mathematics and professional qualifications?

To be on par with the global standards in science and mathematics achievements, Sri Lanka needs a far-sighted viable strategy. Improving teaching and learning in mathematics needs to be a key component in the educational strategy for improving quality, inclusivity, lifelong learning and equity to achieve Sustainable Development Goal (SDG) for Education. The findings of the current study will provide scientific information for designing such a strategy. According to published research, observational studies conducted on mathematics teachers' classroom practices are rare in Sri Lanka (Abeygunawardene and Vidanepathirana, 2019; Keppetigoda and Wannigama, 2015). The current study will contribute to fill this gap to some extent.

Theoretical background

Teaching is conceptualized as a relational process, where teachers, students and subject matter can only be understood relative to one another. Doyle (1988) suggests that teaching and learning situations can be conceptualised as a set of reciprocal interactions among three essential elements in the instructional setting as depicted in Figure 1. Central to

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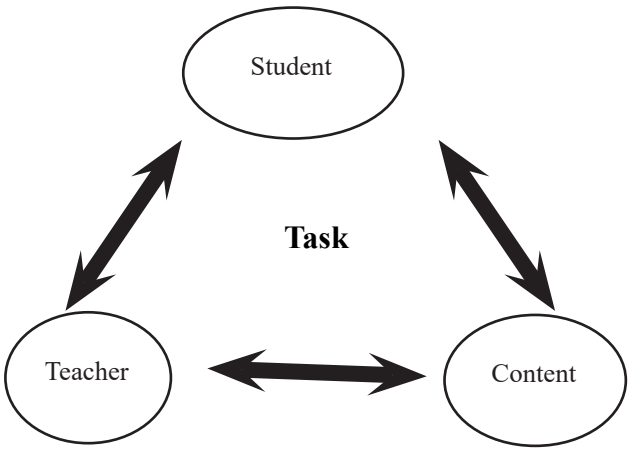

Figure 1: Instructional Core and the Task

this instructional core is the mathematical task used in the classroom (Antonetti & Stice, 2018)

According to Leof Franke *et al.* (2007), teachers and students engage in mutually constitutive relationships in their mathematics classrooms. In this view, teaching is about building relationships among the teacher and students around mathematics and engaging together in constructing mathematical meaning (Leof Franke et al., 2007). Classroom practices are what teachers do in their classrooms, but it is more than how teachers behave or the actions of individual teachers. 'Practice is action informed by a particular organizational context' (Leof Franke et al., 2007). In the current study, we define mathematics teachers' classroom practices as 'practices that are used by the teachers to build relationships among the teacher, students and the subject content to construct mathematical meaning in their classrooms'.

Effective classroom practices in mathematics teaching

Using research based evidence, the National Council for Teachers of Mathematics (NCTM) emphasises the importance of learning tasks, classroom discourse and student-led discussions in teaching mathematics to create a classroom environment where all students contribute and learn (NCTM, 1991). Professional Standards for Teaching Mathematics (NCTM, 1991) further iterates that mathematics needs to be taught as a dynamic tool for thought and not just as a set of operations to be learned. Furthermore, NCTM (2014) identifies eight effective practices of mathematics teaching based on research as follows: 1. Establishing clear goals; 2. Implementing tasks that promote reasoning and problem solving; 3. Use and connect mathematical representations; 4. Facilitating meaningful mathematical discourse; 5. Use of purposeful questions; 6. Building procedural fluency from conceptual understanding; 7. Supporting productive struggle in learning mathematics; and 8. Eliciting and using evidence of student thinking (NCTM, 2014).

Qualitative research asserts that the students of teachers who teach both higher-order thinking skills and lower-order thinking skills outperform students whose teachers are only focusing on conveying lower-order thinking skills (Wenglinsky, 2002). Kaur (2009) states that 'good teachers of mathematics' in Singapore use a range of tasks including both lower and higher order thinking skills and 'incremental instructional cycles' (which build on knowledge developed in the previous cycles) in their mathematics lessons. Good practices of mathematics teaching in Singapore include attention to individual needs; monitoring student understanding and guiding students with difficulties during seatwork; and detailed review and discussion of work done in class and at home (Kaur, 2009; Kaur *et al.*, 2021).

Opdenakker and van Damme (2006) in a study, of mathematics teachers' classroom practices and teacher characteristics that was conducted in Belgium, concluded that effective classroom practices in mathematics are characterised by a learner-centred teaching style and by good class management skills. However, more recently, Kaur *et al.* (2021) inferred in a mixed methods study of mathematics teachers' instructional practices in Singapore that effective teacher actions cannot be simply labelled as student or teacher directed, or fluency or conceptually oriented. Experienced and competent mathematics teachers in secondary schools in Singapore use an instructional core comprising the DSR cycle where D, S and R stand for 'Development, Student work and Review of student work', respectively. The approach of experienced and competent mathematics teachers seems to be a dynamic combination of both teacher-centred and learner-centred elements that are orchestrated in tandem to achieve fluency by all students (Kaur, 2021). These contrasting findings in different contexts suggest the importance of cultural and other contextual factors that mediate effective classroom practices in mathematics teaching**.** Further, they imply the need to use context based mixed methods studies in identifying more effective approaches of mathematics teaching in different contexts.

The definition of classroom practices in mathematics classrooms stated at the beginning of this section is based on socio cultural learning theory which advocates the use of context based qualitative studies to understand classroom practices. However, in contrast to this view common practice in large scale studies of classroom practices is to use standardised, structured observational instruments which are based on teacher effectiveness research (Lindrof and Sammons, 2018). Since our intention is to investigate

the classroom practices of mathematics teachers in a sample of 49 schools in the selected Province, we decided to use a standard, structured observational instrument that is used to collect quantitative data from a relatively large sample of mathematics teachers' classroom practices at secondary level. To supplement quantitative observational data qualitative data were also collected through a semi-structured observational schedule.

MATERIALS AND METHODS

In the current study, we have used a standardised observation schedule adapted to Sri Lankan context and a semi-structured observational schedule.

The data collection instruments: Ingram *et al.* (2018) reviewd six frameworks that can be used to assess mathematics teaching that are developed in UK, selected European countries and USA. The Quality of Teaching (QoT) framework is one of them and it is developed by school inspection teams of five European countries, specifically focusing on mathematics teaching in primary schools and high quality reviews of research on classroom practices of teachers (Wim, 2007; Ingram *et al.,* 2018). Subsequently, it has been used in mathematics and other curriculum areas in secondary schools within UK (Ingram *et al.*, 2018). According to Wim (2007), the quality of teaching can be assessed in a reliable and valid way using the five standards of the framework, namely, *efficient classroom management* (4 indicators with 10 best practices); *safe and stimulating learning climate* (7 indicators with 19 best practices); *clear instruction* (7 indicators with 22 best practices) ;*adaptation of teaching* (2 indicators and 6 best practices); and *Teaching learning strategies* (3 indicators and 6 best practices). Furthermore, the five standards of quality of teaching are positively and significantly correlated with pupil involvement, attitude, behaviour, and attainment.

For the current study, we have selected the Quality of Teaching (QoT) framework (Wim, 2007) for two reasons. First, it is an event sampling instrument that helps to assess to what extent teachers use best practices relevant to selected standards of mathematics teaching. Second, we were interested in assessing the general quality of teaching of mathematics teachers by identifying strengths and weaknesses of their classroom practices (Table 1).

The observers score each indicator on a scale of 1-4 depending on the relative strengths and weaknesses in the teacher's use of a given set of best practices in the particular classroom. The following key is used to rate each indicator: 1 = Predominently weak, 2 = more weaknesses than strengths, 3 = more strengths than weaknesses, 4 = predominantly strong. For each best practice observed in a class is marked as 1 and each good practice not observed is marked as 0.

The QoT framework that will be called structured observational schedule, hereafter, was translated into Sinhala and Tamil languages and piloted in six classrooms. Then it was adapted and validated to the Sri Lankan context using the views of three teacher educators and 8 mathematics teachers. A pilot study conducted in 4 schools used to further validate the instrument. The pilot study revealed that it was difficult to score all 23 indicators while observing the classroom. Keeping a detailed record of teacher and student behaviours in a semi structured observation schedule during the lesson and scoring the structured observational schedule immediately after the lesson was found to be more practical and effective. For this purpose and to record qualitative information about teachers' classroom practices, a semi structured qualitative observational schedule comprising four columns to record time, observed teacher behaviours, observed students' behavours and other remarks was used in the actual data collection. The remarks column was to record any thing happen in the class that do not belong to the categories of teacher bahavious and students behaviours. These can also be the observers thoughts related to the observations.

The reliability of each of the sub-scale in the structured observational schedule was computed using Chronbach's coefficient of alpha (Table 2).

For two of the scales $\alpha > 0.7$ and the other three it was ranged from 0.64 - 0.69 indicating an acceptable level of internal consistency.

A multi-stage sampling procedure was used in this study. First, a stratified random sample of 49 schools based on the school type was identified and then one mathematics teacher who teaches grade seven from each school was selected randomly for the lesson observation.

A group of 25 teachers including both mathematics and non-mathematics teachers who had recently completed Master of Education or Master of Science Education programmes of one of the State universities in Sri Lanka were selected as observers. To decide the number and

Table 1: A sample item used in standard 1.

Standard	*Indicator*	Rating 1 2 3 4	Best practices	Observed/ Not observed 0/1
1. Efficient classroom management	1.1 Teacher delivers a well-structured lesson		1.1 Teacher ensures clearly recognizable components in the lessons (lesson structure)	

Table 2: Internal consistency (Chronbach's α) of the sub-scales of the instrument.

Sub Scales	Number of indicators	Cronbach's Alpha
Efficient Classroom Management	04	0.675
Safe and stimulating learning climate	07	0.783
Clear Instructions	07	0.722
Adaption of Teaching	02	0.693
Teaching and Learning Strategies	03	0.643

composition of the observers, the purpose of the study and practical aspects of time, experience of the observers in classroom observations, availability of adequate mathematics teachers who were willing to collect data for the study, and the geographical distribution of the sample of schools have been considered.

A one-day training workshop was held for the observers prior to data collection. In the training workshop, the observers were allowed first, to observe a video recorded mathematics lesson while individually recording observed teacher behaviours and students' behaviours using the above mentioned semi structured observation schedule. Immediately after the observation, they were rated the structured observational schedule. The research team consisting of four academics from the university also observed the lesson and rated the schedule individually. A detailed discussion was held afterwards on each of the indicator, the best practices given in the structured observation schedule and the disparities in rating indicators to arrive at a consensus to decide a common set of ratings. This process is used to help the observers to get familiar with the observation framework, develop a shared understanding of the standards, indicators and best practices as well as the rating procedure. Each observer was assigned 1-3 schools depending on their availability during the period of data collection.

Quantitative data were analysed using Statistical Package for the Social Sciences (SPSS) Version 23. Qualitative data collected on student and teacher behaviours during the lesson were analysed using an analytic framework informed by QoT standards, indicators and best practices.

RESULTS

Results are reported in relation to the two research questions. Results of the quantitative analysis of the data collected through QoT framework are presented first. Mean and Standard deviation values of different indicators in each of the five standards are compared to identify relative strengths and weaknesses of classroom practices of mathematics teachers. Secndly, the strengths and weaknesses of teachers' classroom practices identified in relation to the five standards of the QoT framework are presented. Finally, the results of the analysis on the associations among teachers' classroom practices and teachers characteristics are reported.

In the quantitative data analysis, the teachers in the sample were grouped according to gender, their highest educational qualification in mathematics and professional qualifications (Table 3).

Strengths and weaknesses of teachers' classroom practices-Quantitative analysis

Before further analysis, all sub-scale scores are standardized by dividing the sum of all mean scores of the indicators in the standard by the product of the number of indicators and the number of response categories.

As a result of this standardization, the results can be interpreted as: the average teacher satisfies #% of the indicators of the scale (Wim, 2007). Table 4 indicates the results of this analysis.

According to Table 4, all five standards need substantial improvements while standards 2, 4 and 5 require special attention.

Standard 1: Efficient Classroom Management

According to the comparison of means and standard deviations of the above indicators, the teachers' practices were better in ensuring orderly progression of lessons, presenting well-structured lessons and effective time management than in ensuring efficient classroom management (Table 5).

Standard 2: Safe and stimulating learning Environment

The Table 6 indicates the mean and standard deviation for each indicator of Standard 2.

Teachers' practices were stronger in supporting the self-confidence of students and showing respect for the students in behaviour and language use than in the practices relevant to rest of the indicators. Teachers' practices were weak in ensuring a relaxed atmosphere, promoting mutual respect, ensuring cohesion, stimulating the independence of students, and promoting cooperation between students.

Standard 3: Clear Instructions

Means and standard deviations of the seven indicators of the standard are set out in Table 7.

Teachers, practices were stronger in clarifying the lesson objectives at the start of the lesson, evaluating the achievement of the objectives at the end of the lesson, and giving clear instructions and explanations. Teachers' practices were weak in giving clear explanations of the learning materials and the assignments, giving feedback to

Table 3: Profile of the teacher sample.

Teacher characteristics	Categories	Frequency	Percentage (%)
Professional Qualifications	Yes	38	77.6
	No	11	22.4
	Total (n)	49	100.0
Highest qualification in Mathematics	Bachelor's degree	09	18.36
	GCE (A/L)	11	22.44
	GCE (O/L)	29	59.18
	Total (n)	49	100.0
Gender	Male	19	38.78
	Female	30	61.22
	Total (n)	49	100.0

Table 4: Quality of teaching in mathematics lessons for Grade 7 students in the Central Province of Sri Lanka.

Quality Standards (Scales)	Percentage (%) N = 49
Efficient classroom management	62.4
Safe and stimulating learning environment	56.3
Clear instructions	62.3
Adaptation of teaching	49.2
Teaching learning strategies	51.4

Table 5: Indicators of efficient classroom management.

Indicators	Mean	SD
Ensures the orderly progression of the lesson	2.67	0.826
Uses learning time effectively	2.61	0.759
Teacher gives a well-structured lesson	2.57	1.000
Ensures efficient classroom management	2.12	0.949

$$\text{Standardized score} = \frac{\text{Sum of all mean scores of the indicators in the subscale} \times 100}{\text{(No. of Indicators in the sub scale * No. of response choices)}}$$

students, involving all students in the lesson, making use of teaching methods that activate the students.

Standard 4: Adaptation of Teaching

Table 8 sets out the Mean values and standard deviations.

According to the Table 8, mean values of both indicators were less than 2.5 indicating that adaptation of teaching is not frequently occurred in most of the classrooms. In the qualitative analysis two weaknesses emerged as follows. Standard 5: Teaching and Learning Strategies

Table 9 sets out the values of mean and standard deviation relevant to the three indicators of this standard.

Teachers' practices were weak in ensuring the teaching materials are oriented towards transfer and stimulating the use of control activities. However, they were strong in providing interactive instruction and activities.

Strengths and weaknesses of teachers' classroom practices-Qualitative analysis

Two strengths related to 'Efficient classroom management' and 'Clear instructions' emerged while 6 weaknesses emerged in relation to all five standards in the QoT framework. Table 10 summarises the strengths and weaknesses in relation to the five QoT standards. These findings are consistent with and more or less corresponding to the strengths and weaknesses identified in the quantitative analysis.

Table 6: Safe and stimulating learning Environment.

Indicators	Mean	SD
Supporting the self-confidence of students	2.82	0.697
Showing respect for the students in behaviour and language use	2.80	0.763
Ensuring a relaxed atmosphere	2.18	0.697
Ensuring cohesion	2.18	0.834
Stimulating the independence of students	1.98	0.854
Promoting cooperation between students	1.98	1.031
Promoting mutual respect	1.87	0.800

Table 7: Indicators of Clear Instructions.

Indicators	Mean	SD
Evaluating the achievement of the objectives at the end of the lesson	2.96	0.735
Clarifying the lesson objectives at the start of the lesson	2.76	0.855
Giving clear instructions and explanations	2.69	0.742
Giving feedback to students	2.37	0.698
Giving clear explanations of the learning materials and assignments	2.35	0.879
Involving all students in the lesson	2.37	0.809
Making use of teaching methods that activate the students	1.96	0.455

Table 8: Indicators for Adaptation of Teaching.

Indicators	Mean	SD
Adapts the instruction to the relevant differences between students	2.20	0.790
Adapts the assignments and processing to the relevant differences between students	1.73	0.670

Strengths emerged in the qualitative analysis

Clear structure and orderly lesson: Three main categories of lesson structures emerged in the analysis of observation records.

Structure 1: Whole class teaching

Greetings->An introduction -> Teacher modelling -> Students' Individual Practice -> monitoring by the teacher -> Feedback and further practice -> Assign Homework->End

Structure 2: Whole class teaching with Groupwork

This structure was followed when the teachers used group work, discovery method or gaming. Following steps and sequence appeared in such lessons.

Greetings >States/writes the lesson title-> explains that the teacher will use group work-> Grouping students-> Distributing groupwork-> Monitoring and providing support to groups->students present their work to the whole class->Feedback and reinforcements >End.

Structure 3: Problem solving by the student volunteers

It seems that this structure is generally followed when the teacher is not specifically prepared for the lesson; typical structure appeared was as follows:

Greetings-> Brief introductory remark-> writes a problem on the board->call a student to the blackboard-> Ask the student to solve the problem on the board-> Check with the students whether the answer is correct-> Gives another sum->Name another student to do the sum-> checks the answer and instructs how to do the corrections->Repeat the process if the time permits-> End.

According to the observation records the few teachers who adopted the Structure 3 came to the classroom empty handed.

Of these three Types of structures, the structure 1 and 2 appear more effective than the structure 3 because they provide an overview of the lesson, use teacher demonstrations/or student activities and students' presentations. When compared with the characteristics of effective lesson progression and structure (Rosenshine and Stevens, 1986) many teachers need improvements to their practices, especially in introducing the lesson objectives

Table 9: Teaching and Learning Strategies.

Indicators	Mean	SD
Provides interactive instruction and activities	2.55	0.891
Stimulates the use of control activities	2.00	0.866
Ensures the teaching materials are oriented towards transfer	1.61	0.731

Table 10: The summary of the qualitative findings related to strengths and weaknesses in classroom practices.

Standard	Strengths	Weaknesses
1. Efficient Classroom Management	1. Orderly progression and clear structure in the lesson	1. The lack of attention to the whole class throughout the lesson
2. Safe and stimulating learning climate		2. Limited use of stimulating lesson materials 3. Less prevalent group and pair activities that promotes cooperation among the students
3. Clear Instructions	2. Orderly lesson progression (Combined with the strength in Standard 1)	4. Limited opportunities for active learning
4. Adaption of Teaching		5. Lack of attention to set differentiated learning and assessment tasks to suit different ability levels
5. Teaching and Learning Strategies		6. Limited opportunities for interactions and collaboration among students

at the beginning, recalling relevant prior knowledge and experiences, drawing attention to key points during the lesson and ending the lesson by reviewing the achievement of objectives.

Weaknesses emerged in the qualitative analysis

1. The lack of attention to the whole class throughout the lesson.(Standards 1and 3)

Effective management of lessons also dependent upon the teacher's attention to the whole class throughout the lesson and motivating distracted or disengaged students. Observers in their qualitative records stated that classroom management needs improvement in some of the classrooms (16%) where teachers did not pay attention to the whole class throughout the lesson while neglecting students who were distracted, disengaged, or needed the teacher's special attention or support. Typical observations in such lessons were as follows:

> There are 28 students in the classroom. About 15 students participate in the lesson and independently do the calculations. Others doing their calculations by copying from their neighbours or just keeping quiet and doing nothing.
>
> In the last row, there is a boy who keeps his hand on his cheek while doing nothing. The teacher does not seem paying attention to him".
>
> Observation - 013/0322

The teacher appear to lack attention to what is going in the whole class or 'with-it-ness' (Kounin, 1970) and did not have a plan to serving both gifted students and students who need teacher support in the above situations.

2. Limited use of stimulating lesson materials (Standard 2)

In most of the lessons, only lesson material used is the textbook, and only teaching aid used is the black/ whiteboard. However, the few teachers who used student-centred approaches used teacher made work cards and/or other materials as indicated by the following extract.

> Measuring cylinders are placed on the tables. Teacher distributes measuring cylinders of different sizes and water to the students. She also gave them papers to write their answers to the questions put up on the whiteboard.
>
> Observation 010/0319

Most teachers used the textbook only to assign relevant tasks during the lesson and to assign homework. However, 2/49 teachers in the sample came to the class empty handed. Reportedly, one such teacher did not use even the blackboard. The observer further reported:

> Teacher asked questions on Volume. Then he started to explain a cube. Showed figures from a borrowed textbook. He didn't draw any cube on the board.
>
> Teacher explained the sums verbally. Instructed the students to do the activities in the textbook. Students did not try to solve the problems on their own. They did them according to the teachers' instructions. Most of the students were silent. All teacher questions were answered by a few students.
>
> Observation 130/1347

3. Less prevalent group and pair activities that promotes cooperation among the students (Standard 2)

Group or pair activities were used in only 25% of the lessons observed. One observer particularly recorded following observation in a lesson where the teacher used a more teacher centred approach to teaching.

> Students do the sums individually. Following behaviours could be observed among the students: 'not allowing their neighbours to look at their work'; Not explaining things to others. Closing the book'.
>
> Observation 011/0331

The student behaviours highlighted in the above extracts are contrary to the expected behaviours in an effective mathematics lesson that facilitates meaningful mathematical discourse (NCTM, 2014). Extensive literature on teacher effectiveness and mathematics teaching and learning suggests the teachers to use meaningful mathematical discourse which allows dialogue, discussion about meanings and connection between different mathematical ideas and contexts (NCTM, 2019); collaborative problem solving in whole class and in small groups (Brown et al., 1998).

4. Limited opportunities for active learning: (Standard 3)

The theoretical background presented in this paper highlights the importance of the mathematical task and discourse in the classroom to create and share mathematical understandings among the learners and the teachers. Questioning methods and the use of challenging mathematical tasks, conversational and discussion forms of interactions are useful in this process. Observers reported that teacher-pupil interaction was good in many lessons. However, observers rarely reported teacher questioning, conversations that stimulate thinking among learners and opportunities to share students' mathematical understandings. Following extract (Table 11) provides a glimpse of a lesson which facilitated active learning.

> Observation - 009/0326

The use of real-life examples, more opportunities for interactions with the teacher and peers appear to facilitate active learning in the above lesson.

5. of attention to set differentiated tasks to suit different ability levels (Standard 4)

It has emerged that teachers rarely attempted to set learning and assessment tasks to suit the different ability levels of the students in the classroom. Following extract highlights a classroom situation where the teacher didn't have an effective plan or strategy to pay attention to students who needed the teacher's intervention, guidance, or support.

> Throughout the lesson, many students were engaged in practice activities while the teacher was monitoring their work and providing feedback to students who showed their work to the teacher. Teacher moves around the class, checks student's work, and provides feedback to students who showed their work to the teacher. Those who quickly complete the tasks are not given additional tasks. There are a few students with difficulties in reading and writing. But the teacher doesn't have specific activities planned for them.
>
> Observation - 013/0322

Adaptive teaching requires teachers to ensure all students attain the lesson objectives by engaging in differentiated tasks that are designed to suit individual capacities. It seems that, this is not effectively practised in many classrooms because the teachers did not have an effective plan.

6. Lack of opportunities for effective interactions and collaboration among students (Standard 5)

According to the qualitative observations, opportunities for effective interactions among students were recorded only in the 25% of lessons where teachers used gaming, discovery learning or group activities.

Associations between classroom practices and teacher characteristics

The data were further explored to compare whether there were any statistically significant differences in the mean scores of indicators belonging to each of the five standards according to the teacher characteristics such as gender, and professional qualifications and highest academic qualification in Mathematics using the Mann-Whitney U test. According to the results of the Mann-Whitney U test, there were no significant differences in any of the indicators of the five standards of classroom practices according to the gender, and professional qualifications. However, there were significant differences ($p<0.05$) in 5 out of eleven indicators belonging to the standards of Efficient classroom management and Clear Instructions according to the teachers' highest qualifications in mathematics. To assess the significance of differences among the teachers with different categories of highest qualifications in mathematics a Kruskal Wallis H test was used.

Differences according to the teacher's highest educational qualification in mathematics

There were significant differences ($p<0.05$) between the scores of 3 out of 4 indicators belonging to Efficient classroom management and 2 out of seven indicators belonging to Clear instructions according to the teacher's highest educational qualification in mathematics. Table 12 summarises the results of the Kruskal Wallis H test.

According to Table 12, teachers who offered mathematics as a subject in their bachelor's degree or at the GCE (A/L) indicate significantly higher mean ranks than the teachers with GCE (O/L) qualifications. Teachers belong to former category are more likely to give a well-structured lesson; use learning time efficiently; ensure efficient classroom management; give clear explanations of the learning materials and the assignments and making use of teaching methods that activate students than the teachers who studied mathematics only up to GCE (O/L).

DISCUSSION AND RECOMMENDATIONS

There are three key findings in this study. Firstly, the Mathematics teachers' classroom practices need to be improved concerning all six standards while specific attention for improvement is necessary for providing a safe

Table 11: An extract from observation record related to active learning.

Teacher behaviours	Student behaviours
Started the lesson by discussing about making a concrete mixture.	Provide answers to teacher questions.
Introduces the concept of Ratio	Listen attentively.
Directs the students to group work on finding ratios.	Follow teacher's instructions
Distributes activity sheets	Discuss and do the activity.
Monitors and supports group activities	Ask questions from the teacher
Makes corrections, provides feedback to the groups presenting their work.	Student groups present and explain their work to the whole class

Table 12: Associations between teachers' classroom practices and the highest qualification in mathematics.

Quality standard	Relevant indicators	p-value	Highest qualification in Mathematics		
			Mean Rank		
			GCE O/L or other (N=29)	GCE A/L (N=11)	Bachelor's Degree (N=9)
Efficient Classroom Management	Gives a well-structured lesson	0.015	20.57	29.00	34.39
	Uses learning time efficiently	0.010	20.74	27.73	35.39
	Ensures efficient classroom management	0.001	21.48	21.73	40.33
	Ensures orderly progression	0.585	24.36	23.36	29.06
Clear Instructions	Gives clear explanations of the learning materials and the assignments	0.003	20.12	28.09	36.94
	Makes use of teaching methods that activate the students	0.027	22.90	23.95	33.06
	Clarifies the lesson objectives at the start of the lesson	0.383	22.98	29.18	26.39
	evaluates whether the objectives have been achieved at the end of the lesson	0.725	25.00	27.05	22.50
	gives clear instructions and explanations	0.537	23.88	24.36	29.39
	gives feedback to students	0.394	23.57	25.00	29.61
	Involves all students in the lesson	0.383	23.36	25.45	29.72

and stimulating learning environment, adaptive teaching, and teaching learning strategies that facilitate transfer of learning, metacognition and interactive teaching and learning.

Secondly, qualitative data supports the above findings and provides insights on the strengths and weaknesses of mathematics teachers' classroom practices. Having a clear structure with identifiable components in the lessons is a relative strength but the lack of attention to the whole class throughout the lesson is a weakness affecting effective classroom management. Rare use of stimulating learning materials and limited opportunities for pair and group activities are weaknesses affecting the safe and stimulating learning environment. The latter weakness affect the facilitation of meaningful mathematical discourse in the classroom which is among the 8 effective practices recommended by NCTM(2014). Orderly progression of the lesson is a particular strength of the mathematics teachers which helps them to provide clear instructions and eff. However, the limited opportunities provided to students for active learning is a weakness that affect the development of students' reasoning, problem solving, communication and representation skills. A particular weakness in adaptation of teaching is the lack of attention to set differentiated tasks to suit different ability levels of students. Providing additional support for slow paced learners was also not frequently observed.

Thirdly, teachers' classroom practices are independent of their characteristics such as gender, medium of instruction, and professional qualifications. However, the teachers' classroom practices related to 5/11 indicators belonging to the standards on efficient classroom management and clear instructions are significantly associated with the teacher's highest qualification in mathematics. Teachers who offered mathematics as a subject in their bachelor's degree or at the GCE (A/L) are more likely to give a well-structured lesson; use learning time efficiently; ensure efficient classroom management; give clear explanations of the learning materials and the assignments and making use of teaching methods that activate students than the teachers who studied mathematics only up to GCE (O/L). The profile of mathematics teachers in the sample indicates that there are 65% of teachers without GCE (A/L) or Bachelor's degree qualification in mathematics. Heterogeneity of teacher qualifications among mathematics teachers and the above findings emphasise the importance of recruiting more mathematics teachers with higher qualifications in mathematics and the professional development of existing mathematics teachers.

The findings imply a need to transform teacher behaviours and practices to promote: the use of stimulating teaching materials and adapting them to the level and experience of students; tasks that promote higher order thinking rather than mere practice; cooperative learning and group activities in the classroom; active learning; opportunities for independent learning; scaffolding to support slow paced learners and more conversational and discussion forms of teaching.

Suggestions for improving policy, practice, and research:

The above key findings have many implications for mathematics teacher education, teacher professional development and teaching learning practices used by teachers at the classroom level. Following suggestions may be helpful for improving the situation.

• Change of teachers' classroom practices can be made possible by allowing teachers to reflect upon their own theories and practices to bridge the gap between those theories and their actual practices (Hardman *et al*, 2016). Therefore, we suggest different programmes of initial and continuing teacher education, and School Based Professional Teacher Development (SBPTD) to provide opportunities for teachers to engage in appropriate learning tasks and classroom based action research to critically examine their beliefs and practices.

• Furthermore, the transformation of mathematics teachers' classroom practices may require continuing professional development programmes that upgrade teachers' pedagogical competencies over a sustained period. Copur-Gencturk and Papakonstantinou (2016) indicates that teacher practices do change with the experiences that they gain in such programmes.

• Provide opportunities and incentives for existing mathematics teachers to upgrade their content knowledge, and pedagogical skills in mathematics through Continuing Professional Development (CPD) programmes.

• Improve teachers' classroom practices by empowering them to use:

  - o tasks that require thought and higher order thinking rather than the tasks that leads only to repeated practice,

• meaningful mathematical discourse which allows dialogue, discussions on meanings and connection between different mathematical ideas and contexts,

  - o teaching learning strategies such as authentic problem solving, inquiry based learning, collaborative learning and projects that provide more autonomy for students to develop and discuss their methods and ideas (Brown *et al*., 1998; Kaur, 2009; NCTM, 2014; Kaur *et al*., 2021).

• It is also necessary to pay attention to the need to utilize stimulating learning materials by the teachers and the need to pay attention to the students who require teachers' additional support for successful learning. For this purpose,

  - o providing digital infra structure and stimulating learning materials to all schools,
  - o training teachers to use digital technologies and multi-level teaching in mathematics classrooms may be useful.

Suggestions for further research: The study was limited to one-time**,** single lesson observations of 49 mathematics teachers across 49 schools using different observers. We admit that the findings of this study can be affected by the observation of a single lesson per teacher, limitations of the data collection instruments that we used, and the use of different observers to observe and evaluate mathematics teachers' classroom practices. In the current study, our data collection instruments were not geared to collect in-depth information about the nature of the mathematical tasks, mathematical discourse used and the students' contributions to learning. The current study with its limited scope of understanding the overall strengths and weaknesses of classroom practices of a large sample of mathematics teachers and lessons is useful to plan interventions at school, provincial and national levels to improve teaching and learning mathematics. However, to understand the complex interaction of teachers, students and mathematical contents in the classrooms and the more effective practices adopted by good mathematics teachers, a sophisticated mix of both quantitative and qualitative methods of classroom observations using multiple observers in the same classroom and digital technologies (Lindorff and Sammons, 2018; Schoenfeld, 2020; Kaur *et al*., 2021) may be necessary.

CONCLUSION

Mathematics teachers' classroom practices need improvements concerning all five standards that we have used to assess the quality of teaching. Specific attention may be given to the use of adaptive teaching, stimulating learning environments, teaching learning strategies and

effective classroom management practices by the teachers. Moreover, it may be necessary to improve teachers' mathematical knowledge and pedagogical practices through improved teacher education and CPD programmes. Finally, we suggest to provide all schools at least a standard set of stimulating teaching-learning materials and self-learning materials in mathematics and digital infrastructure to promote active learning and self-regulated learning.

ACKNOWLEDGEMENT

This study was funded by the Accelerating Higher Education Expansion and Development (AHEAD) operation of the Ministry of Higher Education, Sri Lanka, and the World Bank. Our sincere thanks to all teachers who consented to observe their mathematics lessons and to the anonymous reviewers for their constructive comments.

DECLARATION OF CONFLICT OF INTEREST

The authors declare that there are no conflicts of interests.

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