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INSIDE INDONESIA'S MATHEMATICS CLASSROOMS: A TIMSS video study of teaching practices and student achievement

Human Development Department
East Asia and Pacific Region

DEPARTEMEN PENDIDIKAN NASIONAL
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The study was designed by Dr. Frederick Leung (Hong Kong University). The design was based heavily on the *Teaching Mathematics in Seven Countries: Results from the TIMSS 1999 Video Study* (Hiebert et al, 2003) in order to allow for comparison of Indonesia's results to those of the other seven other countries that conducted similar studies.

The authors of this report were Frederick Leung and Andrew Ragatz (DPhil candidate, Oxford University). Important contributions to the management of the study activities and preparation of this report were made by Ratna Kesuma (Operations Officer, Education Unit, East Asia and Pacific Region, World Bank) and Susie Sugiarti (Operations Assistant, Human Development Sector Department, East Asia and Pacific Region, World Bank).

The Study Team consisted of 10 core team members who are senior mathematics instructors from the Center for the Development and Empowerment of Mathematics Teachers and Education Personnel (P4TK), the Educational Quality Assurance Institution (LPMP), and some junior secondary schools. The study team was led by Puji Iryanti (P4TK) and Ratna Kesuma. Initial data analysis and reporting were performed with the assistance of experts from universities. Technical support was provided by a team from MoNE. Countless hours were put in by the study team which tirelessly analyzed and reanalyzed the videos to provide the essential coded results and produced the initial analysis that contributed to this report. This team was led by Puji Iryanti and consisted of Adi Wijaya, Budiharjo, Erwin Roosilawati, Krismanto, Rachmadi Widdiharto, Reubun, Suhendro, Suwarkono, Yuniarti and Isfarudi.

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List of Abbreviations

Abbreviation	Description
BALITBANG	Research and Development Department within the Ministry of National Education
BAN-PT	National Board of Accreditation for Higher Education
BAPPENAS	National Planning Agency
BERMUTU	Better Education through Reformed Management and Universal Teacher Upgrading
BOS	Major national government program that provides grants to schools for operational costs
BSNP	National Education Standards Agency
CAR	Classroom Action Research
CPD	Continuous Professional Development
D1, 2, 3, 4	Post-secondary diploma (1-year), (2-year), (3-year), (4-year)
DIKTI	Directorate General of Higher Education
GOI	Government of Indonesia
GTT	Non-permanent, school-hired teacher
GTY	Non-permanent, school-hired teacher in private schools
HEI	Higher Education Institution (university, institute, school of higher learning, academy, or polytechnic)
IDR	Indonesian Rupiah
IKIP	Teacher and Education Studies Institute
KKG	Teacher Working Group for primary schools
LPMP	Institute for Educational Quality Assurance
LPTK	Teacher Training Institutions (faculties) within universities
MGMP	Teacher Working Group for secondary schools
MONE	Ministry of National Education
M&E	Monitoring and Evaluation
OECD	Organization for Economic Co-operation and Development
PGSD	LPTK course to upgrade elementary teachers to S1
PGSMTP	Teacher training college for junior secondary school teachers
PIRLS	Progress in International Reading Literacy Study
PISA	Program for International Student Assessment
PMPTK	Directorate General for Quality Improvement of Teacher and Education Personnel
PNS	Civil servant
PPG	Post-graduate professional course of one or two semesters to gain certification
PP	Government Regulation
P4TK	Center for Development and Empowerment of Teachers and Education Personnel (a national agency)

Abbreviation	Description
QITEP	Directorate General for Quality Improvement of Teachers and Education Personnel (also termed PMPTK)
RENSTRA	5-year Strategic Plan
RPL	Recognition of Prior Learning
S1	Degree equivalent to Bachelor's Degree
S2	Degree equivalent to Master's Degree
S3	Degree equivalent to PhD
SD	Primary school
SKS	Credit points gained by university study or its equivalent
SMA	Senior secondary school
SMP	Junior secondary school
SPG	A now discontinued teacher training secondary school
STR	Student-Teacher Ratio
TIMSS	Trends in International Mathematics and Science Study
UT	Open University
UU	National Law

Executive Summary

The following report is the first of a two-stage video study to examine teaching practices and activities in Indonesian classrooms. The first stage is linked to results of the 2007 Trends in International Mathematics and Science Study (TIMSS) where 100 of the 150 classes that participated in the TIMSS examination also participated in this additional video study component. The second stage will also involve 100 classes that will participate in the 2011 exam. The second phase will follow the same methodology, allowing for comparison across years, but will also involve more in-depth analysis of the links between teaching practices and student outcomes and how teaching practices are influenced by teachers' belief systems and subject content knowledge.

Indonesia has been a committed participant in the TIMSS, Program for International Student Assessment (PISA) and the Progress in International Reading Literacy Study PIRLS international standardized student examinations for many years and is one of the few non-OECD (Organization for Economic Cooperation and Development) countries to participate so fully. Indonesian student performance in these examinations has been relatively low, even when taking socio-economic levels into account. For example, for mathematics Indonesia ranked 36th out of 48 participating countries in TIMSS 2007, and its score of 397 was more than one standard deviation below the international average (Mullis *et al*, 2008). The results have been useful in providing an indication of Indonesia's relative standing in student achievement and its progress over time, but the real challenge is to take the next step and translate the results into an understanding of the factors leading to the test scores and what might be done to enhance student achievement in Indonesia.

Teachers certainly play a key role in improving student outcomes, and since 2005 Indonesia has undertaken a major teacher reform effort. A cornerstone policy of the reform is the requirement that all teachers have a four-year degree and become certified by 2015. As part of the certification process, teachers are required to submit a portfolio which is meant to capture information that demonstrates both teacher competency and performance. In the debate of how teachers should be evaluated for certification, a key question arises: *What makes a high-quality, effective teacher?* To answer this question, and in the larger context of the teacher reform, it is vital to understand Indonesia's current teacher situation in terms not only of teacher qualifications but also of teaching practices and teaching effectiveness.

The Indonesia Video Study provides an in-depth analysis of teaching practices leading to insights that can be applied to Indonesia's teacher reform effort. The first phase of the study examined 100 classes across Indonesia that participated in the 2007 TIMSS international exam. It is said that a picture is worth a thousand words; similarly, a video study is able to go beyond traditional surveys or observational techniques to capture a rich set of both quantitative and qualitative information. The analysis derived from the first phase of this study has provided unique, comprehensive insights into what happens in Indonesia's classrooms and has led to the identification of relationships between teaching practices and student achievement.

The study was designed to allow for analysis from three key angles. *First*, it followed the same methodology used in a video study of seven countries that participated in the 1999 TIMSS examination (including Australia, the Czech Republic, Hong Kong, Japan, the Netherlands, Switzerland and the United States). This provided not only a high-quality, proven coding scheme but also the context for a comparison of Indonesia's results with other countries. *Second*, because the video coding also gives a second-by-second breakdown of classroom time, the pattern of each activity throughout the lesson can also be seen, giving what has been labeled a "lesson signature" for Indonesia's classrooms. *Finally*, the fact that the classes involved in the study also participated in the TIMSS examination allowed for the analysis of the relationship of classroom practices and teaching techniques with student mathematics scores. Additional data on students, teachers, schools and classrooms collected for TIMSS could also be used in this process.

Cross-Country Comparisons

The study focused on key dimensions that frame mathematics classroom practices: *Structure of Lessons*, *Content of Lessons*, *Actions of Participants*, *Instructional Practices* and *Classroom Climate and Resources*. The cross-country comparison highlighted similarities and key differences between Indonesia's classrooms and those of the seven other countries. The following is a summary of major findings:

Structure of Lessons:

The average duration of classes in Indonesia was significantly longer than in comparator countries, with lessons lasting 70 minutes compared to the next closest country average of 51 minutes. This is mainly due to Indonesia's practice of grouping two mathematics periods together and having classes only two or three days per week.[1] It does not translate to more mathematics time per week (with Indonesian students actually receiving fewer weekly hours than the other countries), and, as was evident in some classrooms, there are concerns that Grade 8 students may have trouble concentrating for such an extended period of time.

Classroom time was divided into three areas: (1) *mathematics,* (2) *non-mathematics,* and (3) *mathematics organization* time. While most countries had at least 96% of class time dedicated to mathematics, in Indonesia's case it was only 89%. Much more of the lesson time was spent on organizational work (8%) and non-mathematics time (3%) than in other countries.

Mathematics time was also broken into *problem-solving* and *non problem-solving* time. Only 76% of mathematics time was devoted to problems, whereas in other countries problem time accounted for between 81% and 96%. Indonesia also had relatively few independent problems[2], with 3.3 problems on average per lesson. In other countries the number was between 3 and 13. Indonesia did tend to spend more time per independent problem, however, with an average of 6.6 minutes compared to most other countries spending between 3 and 5 minutes.

1 Typically schools do one of two schedules: two periods are grouped together two days per week (2-2), or one two-hour class is held one day and two one-hour sessions are held on other days (2-1-1).

2 Independent problems include group and individual seatwork problems as well as problems worked on with the whole class.

The purpose of lesson time was broken into: (1) *the review of previous content*, (2) *the introduction of new content*, (3) *practice*, and (4) *assessment*. In Indonesia's classrooms the students were given relatively more opportunity to practice, with 37% of all mathematics time dedicated to practice compared to between 16% and 37% in other countries. Most time was spent on introducing new content (43% compared to between 22% and 60% in other countries), but Indonesia spent much less time reviewing material from previous lessons, with only 10% compared to between 24% and 58% in other countries.

Content of Lessons:

The percent of mathematics problems in Indonesia's classrooms that was determined to be of *high complexity* was only 3%, which was much lower than in other countries which ranged between 6% and 39%. Indonesia also had relatively few problems involving applications but relatively more problems involving proofs. The choice of alternative solution methods was not stressed; few students, therefore, had a chance to examine different ways of solving problems.

Actions of Participants:

One of the most striking results of the study was how few words were spoken by both teachers and students compared to the other countries. Counts of words spoken focused on only full-class interaction (rather than group or individual work) and were standardized to indicate the number of words spoken over 50 minutes. Indonesian teachers spoke fewer than half the number of words as in other countries, with only 2,633 words in an average lesson compared to 5,198–5,902. Student words were similar, with only 194 compared to 640–1,108 in other countries. A further striking feature was that the teacher-to-student speaking ratio was much higher than in other countries, with teachers speaking 28 words for every word spoken by students, compared to 8–16 words elsewhere. This indicates that students in Indonesia tend to participate less in a verbal sense. While this is an indicator of student participation, it does not necessarily measure the level of student engagement. Analysis of the classroom videos revealed classes where the students were engaged but not necessarily speaking frequently. Still, the lower verbal communication for both teachers and students may signal less active and engaged participation.

Time was also divided into *public* (full-class) and *private*[3] (small-group or individual) interaction. Indonesia's distribution of 57% for public vs. 43% for private interaction falls in the middle compared to other countries. When public interaction was examined, the most common method was teacher lecture which accounted for 59% of all public interaction time, while 19% of the time was devoted to student-only work (students presenting) and 22% of the time to student and teacher discussion. For private interaction, 55% was spent in small group work while the remaining 45% was individual work. Indonesia tended to use the technique of working in small groups more than in other countries.

Instructional practices:

Compared to other countries, Indonesia had relatively more lessons that included goal statements and lesson summaries. This, theoretically, should lead to improved clarity and flow of the lessons. Use of goal statements and lesson summaries is part of Indonesia's teacher training guidelines, and the video study results show that this training has permeated into the classroom setting.

3 Private interaction is defined to be activities where all students work at their seats, individually, in pairs, or in small groups, while the teacher often circulates around the room and interacts privately with the groups or individual students.

The teaching strategy most commonly used was *exposition* (teacher explaining while students listen and answer closed questions), which made up 52% of all teaching strategy time. *Problem-solving* was the next most utilized technique, at 20%, followed by *discussion*, *practical work* and *investigation* at 15%, 10% and 3%, respectively.[4]

The mathematical processes suggested by problem statements were divided into three types: (1) *use procedures*[5], (2) *state concepts*[6], and (3) *make connections*[7]. Indonesia's use of stating concepts in 35% of problems was much higher than the comparison countries (between 5% and 24%). The use of procedures (41%) was lower than in all but one of the other countries (between 41% and 84%).

Classroom Climate and Resources:

The environment of Indonesia's classrooms was generally conducive to learning. The classes were mainly conducted with few outside interruptions. The quality of the classrooms varied, with most being well-lit and well-resourced, but others operated in dilapidated classrooms with limited resources. Resources used in the classroom varied, with only 9% of classes using projectors and 13% using calculators, but textbooks were used in 93% of the classes. Real-world objects were used in 28% of the classes; this was higher than all comparator countries which only used them between 4% and 21% of the classes.

Indonesia's Lesson Signature

By coding what takes place in the classroom second-by-second and evaluating the video over many different layers, a complete timeline of what happened in each individual classroom emerged. By merging all the classroom results, common patterns of the country could be seen. This is known as the "Lesson Signature". All class times were standardized by breaking each lesson into percentiles from 1 (the beginning of class) to 100 (the end of class). Indonesia's lesson signature was formed using the dimensions mentioned above, with the following striking features emerging:

General Pattern:

The general pattern identified by the lesson team was that classes were generally segmented into three stages. The *introduction stage* typically involved reviewing homework from the previous class. This was followed by the *development stage* which contained introduction of new content. Teachers typically began this stage by motivating students with an explanation of the importance of studying the lesson, followed by questions of prerequisite knowledge that was used in the development of the new material. For the *closing stage,* teachers (sometimes with the involvement of students) built summaries of the day's lesson and gave students tasks to work on as homework problems.

The analysis of the data quantified this general pattern. The following points emerged from the study of the second-by-second timeline analysis:

4 Definitions of these terms are given in the main text.

5 Problem statements that suggest the problem is typically solved by applying a procedure or set of procedures. These included arithmetic with whole numbers, fractions and decimals; manipulating algebraic symbols to simplify expressions and solve equations; finding areas and perimeters of simple plane figures; and so on.

6 Problem statements that call for a mathematical convention or an example of a mathematical concept.

7 Problem statements that imply the problem would focus on constructing relationships among mathematical ideas, facts or procedures. Often, the problem statement suggests that students will engage in special forms of mathematical reasoning such as conjecturing, generalizing and verifying.

- *Lesson segment purpose:* The review of previous material was almost completely performed within the first 20% of class time, and most classes spent fewer than eight minutes on it. Indonesian classes began work on new material earlier in the lesson than in most countries and spent the second half of class conducting practice.
- *Problem vs. non-problem mathematics time:* As mentioned earlier, Indonesian classes spent more time on non-problem mathematics work. This tended to take place at the beginning of class and often took the form of giving definitions, discussing concepts or describing the history of a mathematics problem.
- *Mathematics, non-mathematics and mathematics organization:* While mathematics time made up 89% of all class time, the beginning and end of class tended to be dedicated to non-mathematics time. Often this came in the form of prayer, daily rituals or discussion of other non-mathematics subjects. The class also often concluded with a daily ritual. Mathematics organization time also tended to occur at the beginning and end of class, but there was significant time devoted to it in the middle of class, often during transitions between interaction types (switching to group work, etc.).
- *Public and private interaction:* While 60% of class time was public, there was a distinct pattern of beginning class with public interaction as well as a less pronounced pattern of ending class with public interaction. Private interaction was most prevalent between the 40% and 80% marks of the class timeline.
- *Problem-solving strategy:* Exposition made up over half of all time working on problems. The exposition tended to take place more in the earlier portion of the class, while problem-solving tended to take place in the latter portion of the class.

Relationships between Teaching Practices and Student Mathematics Scores

Regression analysis allows for the detection of relationships between various teaching techniques and student mathematics scores. Caution must be exercised in the interpretation of the regression results because the TIMSS results only provide a snapshot rather than a "before and after" result. Relationships cannot, therefore, be interpreted to show cause and effect. Still, after controlling for key student, household, school and class characteristics, statistically significant relationships between teaching practices and student mathematics scores emerged to provide useful insights into what may be effective teaching in Indonesia. These included the following:

- A constant theme from the regression results was that classes with higher student involvement (e.g., student presentations, teacher-student interaction, and student problem-solving) had higher test scores. Traditional teacher lecturing, on the other hand, had a negative relationship. Although cause and effect cannot be determined, these results indicate that more student-centered learning can lead to better learning outcomes.
- The percent of time spent on *problem mathematics time* (as opposed to *non-problem mathematics time*) had a positive relationship with student scores. This is interesting to contrast with the fact that Indonesia had the lowest percent of problem mathematics time compared to other countries.
- Although rarely used, *assessment* time and assessment-related activities such as quizzes had a positive relationship to test scores.
- The process of setting up a problem with "*use a procedure*" had a negative relationship with student achievement. "*Make a connection*", on the other hand, was not as common but had a positive relationship with student mathematics scores.
- Students in classes where more *proofs* were introduced tended to have higher mathematics scores.

- Classes where the introduction of problems used *mathematics language* tended to have higher mathematics scores than those that introduced problems with *real-life contexts*.
- Use of projectors tended to have a positive relationship with mathematics scores while use of textbooks tended to have a negative relationship.
- In lesson planning, students in classes with teachers that specified they developed the lesson plan with another teacher tended to have higher mathematics scores.

Strengths of Teaching Practice in Indonesia's Classrooms

Many positive results emerged from the analysis, indicating that Indonesia is employing many good practices. In some cases, the results surpass those of other countries. Among the results:

- The classroom environment was often conducive to learning, and mathematics teaching in Indonesia was mainly conducted with few outside interruptions.
- Students were given ample opportunity to practice what they had just learned in the lesson.
- Compared to other countries, students had more time working in small groups.
- Indonesia had relatively more lessons with goal statements and lesson summaries which should lead to improved clarity and flow of the lessons.
- There was more use of real-life objects in the lessons than in comparator countries.

Focus Areas for Improvement

The findings of this video study also point to some areas for improvement in mathematics classroom organization and instructional practices in Indonesia:

- The duration of Grade 8 mathematics lessons was rather long compared to other countries. As a result, students perhaps could not concentrate on the subject matter to be learned for the whole duration of the lesson.
- Much of the lesson time was spent on organization work, with a result that less lesson time was spent on teaching and learning mathematics.
- Not much time was spent on reviewing what had been learned in past lessons before introducing new content.
- Relatively little homework was given, and much lesson time was consumed on practicing.
- Both teachers and students spoke relatively few words in the lesson, and their statements were generally short.
- The ratio of student words to teacher words was very low compared to other countries.
- Very few of the mathematics problems dealt with were of high complexity.
- There were few problems involving applications.
- The choice of different solution methods was not stressed.
- Calculators were rarely used in classrooms.

Additional Observation Notes from the Videos

Although the coding of the videos provided for objective data analysis, it could not always capture what the observers of the videos could see. The study team (who are mathematics experts and practitioners themselves) noted interesting patterns and felt that certain activities were not being properly conducted. Recommendations include:

- There is a need to apply *better time management in the classroom* and to use the time effectively *to teach relevant content*.
- More emphasis should be put on *higher order thinking* in instructional delivery.
- There was often a mismatch in the level of *content coverage* (i.e., the level and the amount of the content covered is equal to the level and the amount understood by a student).
- There is a need to create an environment of *enjoyable learning* to maintain student engagement, involvement and attention.

Policy Implications

While any policy measures to be taken need to ensure that the many strengths of mathematics teaching in Indonesia as listed above are not lost, the various deficiencies above point to some specific improvement measures.

First, while Indonesia's current qualification upgrading exercise introduced by the Teacher Law passed in December 2005 is moving in the right direction and should be applauded, it is important to remember that the mere upgrading of qualifications is not sufficient for high quality teaching. In particular, the educational background of the teachers should match the subjects that they are teaching. In the event that this is not the case, effective in-service professional development activities (including activities in Teacher Working Groups known as MGMP) need to be provided to ensure that teachers are able to build on their qualifications to develop expert knowledge in the field that they are teaching.

Second, the organization of lesson time should be reviewed. The average of 70 minutes per lesson may be too long for children of Grade 8 (although the regression results indicate that longer classes actually have a positive relationship with mathematics scores). More importantly, measures need to be taken to reduce the organizational work of the teacher during the lesson so that more time can be devoted the most important activity in the classroom – that of teaching.

Third, the policy to not allow the use of calculators in mathematics examinations should be reviewed. The calculator is not merely a calculation device. When used properly, it is an extremely useful tool for learning (e.g., in exploring number patterns).

Finally, the policy of promoting student-centered learning appears to be a valid approach, with the more student-centered classes tending to have higher mathematics scores. The relatively low number of both teacher and student words compared to other countries, as well as the relatively high amount of teacher speaking time compared to student time, indicates that the student-centered approach is not being fully implemented in many classrooms. Methods to further promote such an approach in mathematics should be pursued.

Implications for Teachers

Many of the problems dealt with in the Indonesian classroom were not of high complexity. While the teacher should always pitch the level of difficulty and complexity of the subject matter towards the level of the students, care should be taken to ensure that the difficulty level of the content is not too low.

Developing flexibility in the approach to the solution of problems is an important aim of mathematics education. This can be enhanced by more discussion with students on different ways of tackling problems (examining methods) and by encouraging different solutions to the same mathematical problem.

Communication is another important aim of mathematics education. A noticeable finding of this study is the reticence of both teachers and students in the Indonesian classroom. While this may be rooted in the Indonesian culture itself, teachers need to realize the importance of communication in the learning of mathematics. Students need to be given the chance and the encouragement to express themselves verbally.

Assessment activities are very rarely used, but it appears to have a strong positive relationship with student mathematics scores. Increased frequency in the use of assessment may assist in enhancing student learning.

Indonesian students have very little homework relative to other countries. At the same time, a large amount of class time is devoted to conducting practice activities. While practice in class enables students to directly discuss problems with the teacher and other students, it appears that class time is too often being used to conduct practice that could be done as homework.

Section 1

Background and Context

1.1. Background

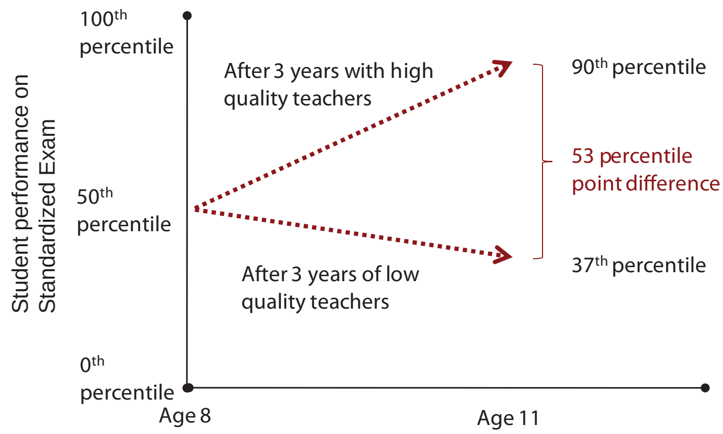
Despite Indonesia's great success in achieving near universal enrollment at the primary and junior secondary level, many students still have low literacy and cognitive skills (Filmer, 2006). Indonesian student performance in international studies has been relatively low, even when taking socio-economic levels into account. For example, for mathematics Indonesia ranked 36th out of 48 participant countries in TIMSS 2007, and its score of 397 was more than one standard deviation below the international average (Mullis *et al*, 2008); in the PISA 2006 study, Indonesia ranked 51st of the 57 participant countries (OECD, 2007). For science, Indonesia's score of 427 in TIMSS 2007 was slightly better than that for mathematics, but it still ranked 35th of the 48 countries (Martin *et al*, 2008). For reading, Indonesia's score was 405 in the PIRLS 2006 study, which was also low, and it ranked 36th of the 48 participant countries (Mullis *et al*, 2007).

Some scholars have attributed the poor performance of Indonesian students to the curriculum. For example, the teachers of the classes participating in the TIMSS 2007 examination indicated that only 20 out of the 39 topics assessed were, in fact, covered[8]. Other factors, of course, can be offered to explain the unsatisfactory situation in Indonesia, but since school children learn most of their mathematics with the guidance of their teachers, it is reasonable to expect that teacher competence in subject matter and pedagogy are major factors in influencing student achievement. As a result, the relationship between teacher competence and student achievement has attracted much attention in the literature (Wright *et al*, 1997; Darling-Hammond, 1999; OECD, 2005; Hiebert and Grouws, 2007).

Teachers play a critical role in student outcomes. According to a meta-analysis by Hattie (2003), which synthesized 51 studies, teacher variables account for approximately 30% of the variations in student achievement, after student characteristics (49%), and are much greater than variables relating to school, home, and peers (approximately 5-10% each). As Barber and Mona (2007) remarked, "the quality of an education system cannot exceed the quality of its teachers", and research has shown that what teachers know and are able to do *does* improve the academic performance of their students (Hill *et al*, 2005). Ma (1999), for example, in a study of elementary school mathematics teachers in the United States and Shanghai, China, found that many Chinese teachers possessed a "profound understanding of fundamental mathematics", and this profound understanding enabled them to invoke rich and relevant pedagogy in teaching elementary mathematics.

8 Education officials noted that the full curriculum, in fact, included all topics in the examination, but the teacher responses are more indicative of what students actually covered by the time they reached 8th grade.

Figure 1.1 **Estimated impact of high vs. low performing teachers on student achievement**



Source: Sanders and Rivers on the Tennessee Value-Added Assessment System (TVAAS)

Students exposed to effective teachers have been shown to outperform dramatically those with ineffective teachers. What is the difference between a good teacher and a bad teacher in terms of learning achievement? Groundbreaking research by Sanders and Rivers on the *Tennessee Value-Added Assessment System (TVAAS)* estimated the impact of the quality of teachers on student achievement. The study found that if average eight-year old students (those scoring in the 50th percentile in a standardized examination) are given teachers of varying abilities, their later achievement levels diverge dramatically. Specifically, one group had high ability teachers (in the top 20%), and the other had low ability teachers (in the bottom 20%) over a 3-year period. At the end of the three years, performance had diverged by more than 53 percentile points. Thus, by age 11, the upper group was scoring in the 90th percentile, and the lower group, in the 37th percentile. Their research also indicates that lower achieving students benefit most significantly from having higher ability teachers.

Cross-country comparisons have highlighted deficiencies in Indonesia's level of teacher quality and teacher support. For example, in a comparative study of the performance of Indonesia, Malaysia and Singapore in mathematics in TIMSS 2003 by Martin and Mullis (2006), it was found that Indonesian students had more instructional time in mathematics but that Indonesian teachers had a lower level of formal education, were less likely to have a degree in mathematics and had less professional support in improving content knowledge and teaching skills.

Cultural context plays a critical role in student learning so that teaching practices that are effective in one country may not lead to the same outcomes in another country. In the TIMSS 1999 Video Study (Hiebert *et al*, 2003), it was found that instructional practices in classrooms in different countries were also significantly different, and even among high achieving countries, there was no single "best" method of teaching mathematics. For example, Japan and Hong Kong SAR are both high performers in the TIMSS exam, but teaching practices and classroom environments differ significantly; this highlights the need to understand cultural contexts in determining teacher effectiveness. In the case of Indonesia, it is important to understand what teaching practices are effective *within the Indonesian context.*

1.2. The Teacher Law

In December 2005, the Indonesian Government passed a law (hereafter referred to as the Teacher Law) that sets minimum academic and professional requirements for teachers. As a consequence of the

Teacher Law, there is a pressing need to upgrade about 80% of the almost three million Indonesian teachers who currently do not satisfy the minimum requirements. In this connection, the World Bank (hereafter, the Bank) launched a project, known as BERMUTU[9], to support the Indonesian government in fulfilling this mission. The scale of investment by both the government and the Bank in this endeavor is huge, and so it is of paramount importance that the effect of the project be closely monitored.

A central aim of the Teacher Law is to upgrade the quality of teachers and their teaching. The ultimate yardstick of success for this initiative is, of course, the improved academic performance of students. Since Indonesia is participating in important international studies such as the IEA TIMSS and PIRLS and the OECD PISA studies, Indonesian student performance in these studies over the years provides a relatively objective measure of any change in outputs of the system. However, the more direct outcomes of this teacher upgrading initiative are improved teacher competence in the classroom, and a study that gauges the classroom performance of teachers will provide an important indicator of the effect of the Teacher Law.

1.3. Why do a Video Study

Classroom performance of teachers may be studied in a number of different ways, but in recent years the use of videos has proved to be a highly effective means of studying classroom activities (Hiebert *et al*, 2003; see discussion below in the Methodology section of the Report). The Bank, therefore, decided to launch a video study[10] in parallel with the BERMUTU project as a means to monitor and better understand the classroom competence of teachers. The design of the video study is such that it links Indonesia's participation in TIMSS 2007 and its intended participation in TIMSS 2011. The coincidence of Indonesia's participation in these two rounds of the TIMSS and the Teacher Law provides a golden opportunity for monitoring the effect of the Teacher Law through exploring the relationship between teachers' classroom performance and their students' TIMSS achievement in 2007 and 2011.

In this video study, the subject of mathematics at Grade 8 was chosen in order to study the effectiveness of the initiatives under the Teacher Law and the BERMUTU project. Mathematics teaching in a sub-sample of the 2007 TIMSS classroom sample was studied using videos, and the results were linked to student achievement in TIMSS 2007. The same study will be repeated in 2011. So that this replication study can be carried out in a manner as close as possible to the 2007 study, **clear documentation of both the implementation and the results of the 2007 study should be kept**. This documentation is provided in the remaining chapters of this report.

9 BERMUTU stands for Better Employment and Reformed Management for Universal Teacher Upgrading. The word "bermutu" in Bahasa Indonesian means "of good quality".

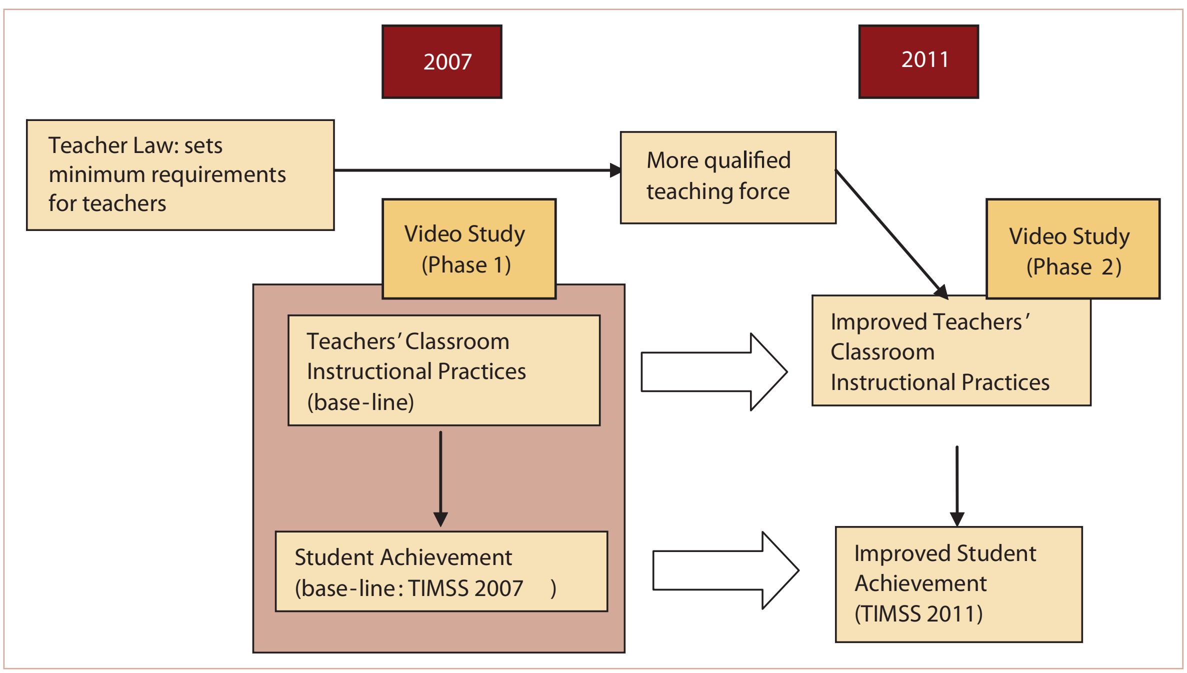
10 Arguments for the use of videos in studying classroom teaching over the use of other means such as questionnaires and live observation were presented in the report of the Pilot of this Video Study by Asrijanty ***et al*** (August 2006).

Section 2
Design

2.1. Conceptual Framework

A central aim of the study is to analyze the changes in teaching practice over time and to measure their effects on student achievement. The Teacher Law sets minimum academic and professional requirements for teachers. The assumption is that teachers with higher qualifications, and following various professional development activities organized in conjunction with the Teacher Law and those provided through the BERMUTU project, will teach better in the classroom. This will in turn lead to gains in academic achievement of their students. Accordingly, this video study is based on a very simple conceptual framework represented in the diagram below:

Figure 2.1 **Conceptual Framework**



The video study should be conceived of in the context of the Teacher Law and what it purports to achieve. As can be seen from the simple model above, phase one of the study documents teachers' classroom instructional practices in 2007. This will provide for the first time in the history of Indonesia a representative documentation of teaching in the Indonesian classroom. A comparison of this documentation with similar studies in other countries will provide an understanding of instructional practices in the current Indonesian classroom in an international context. More importantly, this documentation of teaching practice will act as base-line data with which a replication study in 2011 can be compared. By 2011, it is envisaged that the measures of the Teacher Law will have had an impact on some of the teachers in the sample (since it is a random sample), and so a comparison of the instructional practices of these teachers against the practices of (1) similar teachers in 2007 and (2) those teachers in 2011 who have not yet benefited from the Teacher Law should provide very good evidence of the effects of the Teacher Law.

The framework hypothesizes that teachers' classroom instructional practices, both in the base-line year of 2007 and in 2011, will be related to student achievement as measured by the TIMSS scores. For the 2007 exercise, this will provide valuable data for curriculum developers on the appropriateness of the curriculum and the kind of instructional practices needed for enhancing student achievement. The similar statistical analysis to be performed in 2011 will further test the effectiveness of the improved instructional practices as a result of the Teacher Law.

2.2. Objectives

As mentioned in the conceptual framework above, the purpose of the video study is to monitor the success or otherwise of the initiatives under the Teacher Law and the BERMUTU project. The data collected will enable stakeholders to gain a better understanding of teaching practices in Indonesian classrooms, to see how these practices change over time and how these changes are related to changes in policy, and to gain insight on how these changes have an impact on student achievement.

A secondary purpose of the project is capacity building for relevant personnel in the country. BERMUTU is a project with partial funding from the World Bank and the Netherlands in support of the Indonesian government's initiatives under the Teacher Law, and, as such, the expectation is that the video study should be conducted mainly by personnel in the Indonesian government. The Bank is primarily playing an advisory and supportive role. This not only enhances ownership of the project by local officials and educators; it will hopefully also help them acquire competence in the use of videos as a research tool.

A third purpose of the study is to document teaching practices over time and to integrate video into teacher professional development activities. As a by-product of the video study, the data collected may be used for studying aspects of the Indonesian classrooms other than those focused on in this study. The classroom videos can be used to produce an archive for future use and in teacher professional development activities. The BERMUTU project is supporting teacher working groups made up of teachers from 6-10 neighboring schools who meet regularly to conduct professional development activities. These teacher working groups provide an ideal environment for utilizing video as a means for self-assessment and teacher quality improvement.

To summarize, the objectives for the 2007 component of the study are as follows:

1. To characterize classroom teaching-learning behavior with reference both to curriculum intention and to classroom characteristics in other countries
2. To provide baseline data for comparison with data to be collected in 2011
3. To relate classroom teaching-learning behavior with student achievement in TIMSS 2007 and to determine which teaching methods are effective so as to inform ongoing teaching improvement programs
4. To produce an archive of classroom videos for use in research and teacher development in the future
5. To develop the capacity of relevant personnel in Indonesia.

2.3. Research Questions

Sources of research questions

The research questions were developed through analysis of the Indonesian mathematics curriculum, documents related to the Teacher Law and a review of the literature on mathematics education and video studies. To characterize classroom teaching and to relate classroom teaching characteristics with student achievement, it is necessary to formulate clearly measurable research questions that can be answered from the video data. The research questions came from three sources:

1. The Indonesian mathematics curriculum

A set of preliminary research questions was formulated after a careful study of the Indonesian mathematics curriculum. The curriculum issued by the Indonesian government sets out what students are expected to learn in the discipline of mathematics. These were translated into expected teacher behaviors through asking the question: "What teacher behaviors are needed for students to be able to learn this particular area of mathematics?" Research questions based on the mathematics curriculum document[11] were formulated as follows:

- Does the teaching help students understand mathematics concepts?
- Does the teaching enhance student communication in mathematics?
- Does the teaching enhance student ability in reasoning?
- Does the teaching help develop student ability in problem-solving?
- Does the teaching enhance student competence in applying mathematics procedures?

The teacher behaviors were then operationalized to a set of indicators for each research question through asking the question: "What features should be observed in the video before we can say that such behaviors are present?" This set of indicators for the preliminary research questions can be found in Appendix 1.

2. Documents related to the Teacher Law

Two Commissions were set up after approval of the Teacher Law, and they produced two documents relevant to this study. One of these is on Teacher Competencies and the other on Certification Instruments for teachers. Because these documents define what teacher behaviors and competencies are expected in the country, they formed an important basis for determining the research questions.

3. Literature on mathematics education and video studies

This includes literature on the teaching and learning of mathematics, curriculum documents from other parts of the world and past video studies. To a large extent, Indonesian curriculum documents already reflect elements from the first two kinds of literature (e.g., the NCTM Standards in the United States, 1989). Research questions from other video studies also provided good references for this study. In particular, reference was made to the TIMSS 1999 Video Study (Hiebert *et al*, 2003) and the Learners' Perspective Study (LPS) (Clarke *et al*, 2006).

After taking into account the information gathered from the last two sources, the preliminary research questions arrived at from the Indonesian mathematics curriculum were fine-tuned into the following set of research questions:

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11 Under the Teacher Law, teachers are required to be proficient in four competency domains: pedagogical, professional, personal and social. The research questions here mainly address the pedagogical domain, with perhaps some coverage of the professional domain. However, the video data collected can be used to answer research questions in the social and personal domains as well, but these are not part of what this present video study intends to do.

Characteristics of teaching-learning

- How well are teachers prepared for their teaching?
- What mathematics content is covered in the lessons?
- How competent are teachers in teaching mathematics?
- How are the lessons structured, and how is time managed during the lessons?
- What types of mathematics problems do students solve?
- How are mathematics problems solved?
- What teaching strategies are used by the teachers?
- What types of questions do teachers ask?
- How do teachers assess student learning?
- Are teachers motivated to improve their teaching skills?
- What learning resources are used for supporting teaching and learning?
- What are the profiles of the teachers?
- What are the students' attitudes toward mathematics?
- Which of the characteristics above have positive or negative relationships with high student achievement?

The indicators for these characteristics, together with the sources of data for answering the corresponding research questions from the instruments of the study, can be found Appendix 2. These research questions will guide this video study. The way the study was conducted will be described in the next section.

Section 3

Methodology and Scope

3.1. Justification of a Video Study

A video study of Indonesia's classrooms was deemed to be of high value because of its advantages in providing insights that cannot be gained through other methods. As pointed out above, the purpose of this video study is to examine classroom performance of teachers in order to provide evidence for the effect of the Teacher Law and the BERMUTU project. Classroom performance of teachers may be studied in a number of different ways. The major alternatives are:

3.1.1. Interviews with teachers

Interviews are limited by their reliance on a teacher's memory, honesty and perception of what happens in the classroom. In the literature on teaching practices, there are ample studies of instructional practices gained through teacher interviews. While such interviews may lead to the collection of detailed classroom behaviors and may even be used to probe beyond behaviors to the reasons behind the behaviors, this self-reporting method has obvious limitations:

a. **Teachers in the interviews may have forgotten what exactly happened in the classroom under question,** and so the responses may represent what should have happened rather than what really happened.

b. **For one reason or another (for example, saving face, offering answers which they think the interviewer is looking for, etc.), the teachers may not be honest in responding to the interviewer's questions.** Even when the researcher promises confidentiality, teachers may still fear that their answers will somehow be disclosed to people to whom they don't want the information to be disclosed (for example, government officials or the principal of the school) and so may refrain from responding honestly. On the other hand, teachers may also be sub-consciously defensive, not wanting to admit to themselves and others that they are not performing as well as they want to.

c. **Even if the interviewees are being honest, they may be sincerely mistaken about their own performance in classroom teaching.** In reporting on their classroom practices "honestly", teachers may in fact subconsciously report on what they wanted to achieve rather than what they actually did in the classroom.

d. **The final drawback of interviews is, of course, that they are time-consuming** so that it is not possible for one interviewer to gather data on a large scale. If more than one interviewer is involved, then inter-

interviewer reliability is difficult to establish since the subjective element in the interview is difficult to detect. As a result, it is hard to generalize the findings to the population under study.

3.1.2. Teacher questionnaires

Teacher questionnaires also suffer from the limitations of memory, honesty and perception, as well as inflexibility in their administration. Studying instructional practice through administering questionnaires to teachers is another popular methodology in the literature. The advantage of using questionnaires, in contrast to interviews, is that they can be administered on a large scale involving less manpower, and once the questionnaire is set, the scoring and analysis of results are relatively more objective. If the sample is large enough, generalization of the instructional practices to the population under study may be achieved. However, the teacher questionnaire methodology, being a self-reporting methodology as well, shares most of the problems encountered in the interview approach discussed above. These include forgetfulness of the teachers, dishonesty and teachers being sincerely mistaken. Furthermore, because of the inflexibility in administering a questionnaire, the conditions under which the questionnaire is answered are not known to the researcher; hence, unacknowledged ignorance and unconscious biases are difficult to detect. For example, because of the different background and experience of the respondents, they may have a different understanding of the same words used in the questionnaire. This makes generalization and comparison of the results dubious.

3.1.3. Live observation of classrooms

Observations have the limitations of being intrusive, time-consuming, and challenging in terms of inter-observer reliability and do not allow for re-observation of lessons. A third popular method for studying classroom behaviors and practices of teachers is through live observation of lessons. Data collection in live classroom observation may take a more quantitative, "systematic observation" approach or a more qualitative, "ethnographic" approach. The former uses an observational system to reduce classroom behavior to small-scale units under pre-determined categories (e.g., Flander's interaction analysis categories, 1970) suitable for tabulation and statistical analysis. In the second approach, the observer is "immersed" in the situation being observed for a long duration, interacting with the subjects (called informants) and taking detailed field notes. Words of the "informants" can be recorded down in full with some of these words then quoted verbatim in the research report (see, for example, Delamont and Galton, 1986). While live observation of classrooms overcomes some of the problems of using an interview or questionnaire approach in that it does not rely on self-reporting from the teachers, it has its own problems:

a. **It is an intrusive method**, and as it is likely that the teacher and students are distracted by the presence of the observer, the observed instructional practice may not be typical of the regular behaviors of the teacher when he or she is left alone.

b. **It is time consuming**.

c. **If only one observer is involved, it is not practical to study a large sample**, and so generalization of research findings is a problem. If more than one observer is involved, then inter-observer reliability is difficult to establish.

d. **The most severe problem with live observation is that lessons cannot be re-observed**, and so the foci of observation need to be decided beforehand. When important and interesting findings evolve from the data, it is not possible to go back to the classroom again to collect further data on the same lesson.

3.1.4. The video study approach and its advantages

The video study approach provides many unique advantages for understanding classroom activity. Video study is also an intrusive methodology, and some argue that it may be even more intrusive than live observation, especially when it is done in a community where video-taping is not common. But experience has shown that while students (and their teachers) may be distracted by the video-taping equipment in the beginning of the lesson, this distraction may lapse soon after the lesson begins; if video-taping is done in consecutive lessons, then the effect of the presence of the camera is negligible from the second lesson onward. In this sense, video-taping may be less intrusive than live observation, especially if the latter involves more than one observer.

The advantages of video study are many and make it an extremely powerful methodology for studying the instructional practices of teachers:

a. **Different observers may focus on the same video as the basis of a shared analysis**. This increases inter-rater reliability, and if the required level of reliability is not achieved initially, further training of observers may be conducted to increase the reliability.
b. **The use of multiple cameras may allow different aspects of the classroom to be captured simultaneously**, and synchronization and the use of a mixer will enable the different aspects to be related to each other.
c. **Since the videos are permanent records of classroom activities, multiple analyses may be performed**. The videos may be analyzed repeatedly, at any time and in any place.
d. **The videos may be paused, rewound, fast-forwarded, etc., for further analysis.**

For this study, therefore, a video study approach was adopted to study the instructional practices of Indonesian teachers. Some methodological issues of the present study are discussed below.

3.2. Collection of Data

3.2.1. Unit of Study and Analysis

The unit of analysis -- the classroom -- is the most applicable to the purpose of this study. The objective is to characterize mathematics teaching in Indonesia's classrooms and to identify which of the classroom characteristics are related to high student achievement. The purpose is not to characterize or evaluate performance of individual teachers, and so individual teachers are not the unit of analysis in this study. Making individual teachers the unit of analysis would, of course, have the advantage of enabling it to be more sensitive, but to do this, videotaping of multiple lessons of the same teachers (to obtain a reliable measure of the performance of individual teachers) would be needed. And to study the change in performance from 2007 to 2011, the teachers would need to be traced for videotaping again four years later. This is obviously both too expensive and impractical. As an alternative, the methodology used by the TIMSS 1999 Video Study is followed in this study where a representative sample of teachers is chosen and one lesson per teacher is videotaped. In this way, conclusions are made not about the performance of individual teachers but rather about the performance of teachers as a whole. Thus, comparisons can be made between particular groups of teachers (for example, teachers with S1 qualification versus those who do not have such a qualification) in 2007 and again in 2011.

3.2.2. Sampling

The video study uses a random sub-sample from the 150 schools chosen for the TIMSS sample, which itself is based on a rigorous sampling methodology. A representative sample is needed if we want to generalize the findings to the population under study. There are at least two aspects of representativeness in a video study: whether the teachers chosen are representative of the teachers in the population, and whether the lessons videotaped are representative of the teaching of the teachers concerned; i.e., the issue of typicality of the videotaped lessons.

a. The Sample

A random sub-sample of the TIMSS schools aims to have the selected teachers be representative of teachers in the population. Since we are to relate characteristics of classroom teaching to student performance in TIMSS, the sample for the video study should be linked to the sample of Grade 8 classrooms (and hence teachers) in the TIMSS study. To keep the scale of the study manageable while ensuring representativeness, 100 classrooms (and their teachers) were randomly sub-sampled from the TIMSS sample, and one lesson per classroom was videotaped for study, following the practice of the TIMSS 1999 Video Study. It should be pointed out that since the TIMSS sample was randomly drawn, the randomly drawn sub-sample of 100 lessons was also considered to be representative of the lessons in the country.

The Indonesian TIMSS sample itself was drawn in two stages. First, a random sample of 150 schools was drawn from all the target population schools in the country using a PPS method[12]. Two stratifications were used in the sample: type of school (public or private) and quality of school (based on the national test scores: high, average, and low). Then one Grade 8 class from each selected school was randomly drawn for study, and all students of the chosen classes were asked to take the test and the student questionnaire. Following the practice of TIMSS, the sub-sample for the video study was also drawn using a PPS method from the main sample. After the 100 schools were chosen, the teachers of the Grade 8 classes chosen in TIMSS were invited to participate in the video study.

b. Exclusions

Some schools in the TIMSS sample are in extremely remote locations, and it is difficult and expensive for equipment to be carried there for the video study. Such schools had been excluded before the sub-sample was drawn. The decision of which schools were considered to be in "extremely remote locations" was made by the relevant personnel from Puspendik, and such exclusions were kept to a minimum in order not to jeopardize the representativeness of the sub-sample[13].

On the typicality of the videotaped lessons, two measures were taken. First, teachers were asked in a short questionnaire administered to them (see below) how typical the lessons videotaped were. This, of course, is self-reporting, and the results may not be reliable. The second measure, taken to mitigate the problem of intrusiveness due to the presence of the camera and the videographer, was for each teacher in the sample to be videotaped for two consecutive lessons. The videotaping in the first lesson was for the teacher, students and researchers to get accustomed to the presence of the videotaping personnel and equipment, and only the videotape for the second lesson was used in the data analysis. (The teacher and students were not told about this part of the design.)

12 PPS stands for "Probability Proportional to Size". The sample is chosen in such a way that the probability of a school being chosen is proportional to the number of Grade 8 students in the school.

13 The Educational Assessment Centre suggested that two of the 150 TIMSS schools be excluded from the video study, and this was considered acceptable by the international consultant.

3.2.3. Data

A rich array of data was captured for the video study, including the video data, teacher questionnaires, student questionnaires, field notes from the observation team and TIMSS data, which included questionnaires and test results. The kinds of data collected and the standardized data collection procedures included are described below.

a. Video Data

Two cameras were used to videotape classroom sessions, with one tracing and focusing on the teacher and a stationary one focusing on the whole class of students. Because of the limitation of space in some of the classrooms, a wide angle lens was used for the camera that captured the whole class image. Mixing of the two tapes (for both images and sound) was done by one of the researchers on site, so the videotaping for each lesson produced three sets of video data: the teacher image tape, the whole class image tape, and the mixed image tape. These tapes were ready immediately after the lesson, and so they could be used for the teacher and/or student interviews (see below). Only the mixed image tape was used for the interview and data analysis, but the teacher and whole class tapes were kept in an archive in case there was a need to go back to the originals.

b. Data Collected for the Video Study

To provide background information for the analysis of the video data, many other forms of data were collected:

Teacher questionnaire
Immediately after videotaping, a questionnaire was administered to the teacher whose lesson had just been videotaped. Since the same teachers had taken the TIMSS questionnaire where general questions on mathematics teaching and learning were included, this video study questionnaire only focused on two areas: details about the lesson videotaped and the teacher's experience in in-service professional development activities. The latter is important since in 2011, it will be important to compare the performance of teachers who have received in-service activities because of the Teacher Law with those who have not yet benefited from the Law. Issues asked in the questionnaire included qualifications of the teacher, recent in-service professional development activities, information on the lesson videotaped, teacher's ideas about the planning and implementation of the lesson, typicality of the teaching, typicality of student behavior, etc.

Student questionnaire
A short questionnaire was administered to all the students in the class being videotaped. Again, since the same students were taking the TIMSS questionnaire, this video study questionnaire only focused on information about the lesson videotaped with the results then linked to the TIMSS student questionnaire. Questions were asked on the typicality of the videotaped lesson, whether students understood what was covered in the lesson or not, whether they enjoyed the lesson or not, what they felt were important or interesting points in the lesson, etc.

Interviews with teachers and students
Interviews were carried out with the teacher and a random group of students after the videotaped lesson. Interviewees were asked to elaborate on what had happened in the videotaped lesson.

Field notes or classroom observation records
Field notes on events in the lessons or events that could not be captured by the video images were taken by an observer. The field notes also included a brief description of the structure of the lessons as well as points that the observer found significant or interesting.

Lesson plans

Teachers were asked to submit a copy of the lesson plan or Learning Implementation Plan (RPP) for the lesson videotaped. These lesson plans provided information for making a judgment on how well prepared teachers were for the videotaped lesson. In general, the characteristics looked for in a good lesson plan include the following:

- Carefully planned teaching-learning activities which will be a learning experience for students
- Systematic steps in carrying out the activities to attain the learning objectives
- Steps in the learning process specified in detail, so that the plan can be easily understood and used by other teachers without causing different interpretations of the process.

c. TIMSS Data

The fact that the schools involved in the video study also participated in TIMSS provided a rich set of additional data collected through the TIMSS survey instruments. These datasets included:

- TIMSS results: mathematics scores broken down by question type (geometry, algebra, numbers, data and change)
- Student surveys (questions on home characteristics, student background, student perceptions of mathematics and extracurricular activities)
- Teacher surveys (background and perceptions)
- School surveys (school conditions, resources, safety, parental involvement and perceptions)

3.2.4. Data Collection Procedures

Data collection took place between mid-January and the end of April 2007 and involved significant logistical planning. In order to videotape lessons in 100 schools within this relatively short span of time (given the diverse geographic areas where the schools are located), five teams of researchers were involved in conducting the videotaping simultaneously. Each team consisted of two technical people and one member with expertise in the field of mathematics education. One technical person handled the teacher camera and followed the actions and movements of the teacher (the whole class camera was stationary and did not need to be staffed), and the other technical person did the on-site mixing of the two images. The third person in the team was the observer and was responsible for taking field notes (see above). He or she was also responsible for administering the questionnaires and interview of the teachers/students.

The tapes were digitized and compressed as soon as possible while the teams were still in the field so that immediately after the data collection period, a digitized and compressed dataset was ready for coding and analysis.

3.3. Data Coding

Data coding (and later analysis) was done using the *StudioCode* software, and a "data coding tree" was constructed based on the research questions. To ensure the reliability of coding, at the beginning of the process, a selection of lessons was coded by all the coders under the supervision of a consultant, and the inter-rater reliability for the codes was calculated. The coding proceeded after an inter-rater reliability of 85% had been achieved. When about 50% of the lessons had been coded, this exercise was repeated one more time to ensure that the coding was done reliably throughout the whole coding exercise. After all the videotaped lessons were coded, they were transcribed to facilitate data analysis.

3.4. Data Analysis

Data analysis was conducted by the Indonesian research team under the advice of the consultant who had conducted a similar study in Hong Kong. Firstly, the data was analyzed and presented in a descriptive form, using representations such as bar charts, percentages, medians, modes, standard deviations and ranges. Then the data was analyzed inferentially using correlation, regression and SEM (standard error of the mean). In addition to analyzing the data using the statistics tools available in the *StudioCode* software, data analysis was also performed using standard statistical packages such as SPSS, Microsoft Excel, and LISREL.

The data was analyzed with reference to the research questions based on the coded data. In the first phase of the analysis, the video data and other data (questionnaires, interviews and classroom observation records) were analyzed, and the results were compared with those of seven countries of the TIMSS 1999 Video Study. In the second phase of the analysis, correlations between the teaching-learning practices identified in the video study and TIMSS 2007 scores were computed.

3.5. The Research Team

The Research Team consisted of local experts from various institutes and with diverse backgrounds. It had 10 core team members who are senior mathematics instructors from the Center for Development and Empowerment of Mathematics Teachers and Education Personnel (P4TK), the Educational Quality Assurance Institution (LPMP), and some junior secondary schools. Data analysis and reporting were performed with the assistance of experts from universities. Technical support was provided by a team from MoNE.

3.6. Achieved Sample and Problems Encountered

The target sample was 100 classrooms, but 101 classrooms were eventually videotaped (see reasons below). The 101 schools included both public and private schools and were spread out over 51 districts in 17 provinces across the country (including six provinces in Java, five in Sumatera, three in Sulawesi, and the provinces of South Kalimantan, Nusa Tenggara Timur, and Nusa Tenggara Barat).

In the process of conducting this video study, the team found several constraints with respect to the condition of the teachers and students in the research sample. These can be divided into four types, with the problems and the ways they were dealt with summarized below:

No.	Type of Problem	Handling of Problem
1	Different teacher and students	**Excluded from sample**
2	Different teachers	**Excluded from sample**
3	Different students	**Excluded from sample**
4	**Repetition of lessons**	**Not excluded from sample**

The sample classrooms where teachers or students were different from the TIMSS sample were removed from the TIMSS regression analysis linking student achievement to classroom practices. Dropping these samples was necessary because the links between teaching practice and student mathematics scores would have been invalid. For the understanding of what goes on in Indonesia's classroom, though, the 28 invalid classroom sessions were considered useful in providing insights into teaching practices. In one class the students took an examination for the full period and because there was no interaction or variation in activities, the core team decided to remove this class from the analysis on teaching practices. This left 72 valid schools for the analysis presented in this report. A comparison of the 72 valid schools and 28 dropped schools was performed and interesting differences were discovered. A summary of the comparison results can be found in *Appendix 4: Comparison of Full Sample Results with Subset*. For the purposes of presentation within this study, though, only the results of the 72 valid classrooms are included.

The number of cases for each type of instrument available for analysis is presented in the table below.

Type of Instrument	Total Cases
Video data	**101**
Teacher questionnaire	**84**
Student questionnaire	**3679**
Teacher interview	**101**
Classroom observation record	**101**
Learning Implementation Plan (RPP)	**88**

3.7. Lessons Learned through the Implementation of the Video Study

Through the course of implementing the video study, many lessons arose which are important both for the analysis and for planning for the second phase of the study which will take place in 2011. The following is a summary of the lessons learned:

Several schools attempted to change the sampled teacher with their best teacher when videotaping took place. Accurate data of students and the teacher in the class sampled are necessary for confirmation. Some schools tried to fix up classrooms (painting, replacing old tables, etc.) in order to have a good appearance. Prior to implementation of the study, a clear understanding by the teachers and their principals on the purpose of the study (portraying the actual situation in Indonesia classrooms) is necessary.

The study requires involvement of people who are experienced in teaching mathematics, who know how to conduct research and who can devote significant time to the study. To maintain continuity of the study, four to five people are needed to form the core team to work full-time from the beginning until the end.

To run the study smoothly, the study team should own and be well-trained in using the software and the equipment. The video data coding requires the use of special software (*StudioCode*) which is quite expensive, requires special skills to operate and runs only on Apple computers which are uncommon in Indonesian institutions.

Section 4

Video Results and Cross-Country Comparisons

Findings of the study are reported in this chapter in four sections: (i) teacher background, (ii) lesson structure, (iii) lesson content and (iv) instructional practices. First, the *Teacher Background* section present characteristics of the teachers videotaped to give readers an idea of the general profile of the teachers in the sample. Since the sample is a representative[14] one, the profile should tend to reflect the general profile of the population of Grade 8 mathematics teachers in Indonesia. The *Lesson Structure* section focuses on the length of the lessons; how much time is dedicated to mathematics, non-mathematics and mathematics organization activities; the purposes of various segments; and the type of interaction (full class, individual and group work) that takes place. The *Lesson Content* section focuses on the mathematics content of the lessons and assesses the complexity of problems and whether the problems involved applications or proofs. The *Instructional Practices* section focuses on how the mathematics problems were presented and worked on, the opportunities of teachers and students to talk and resources used during the lesson.

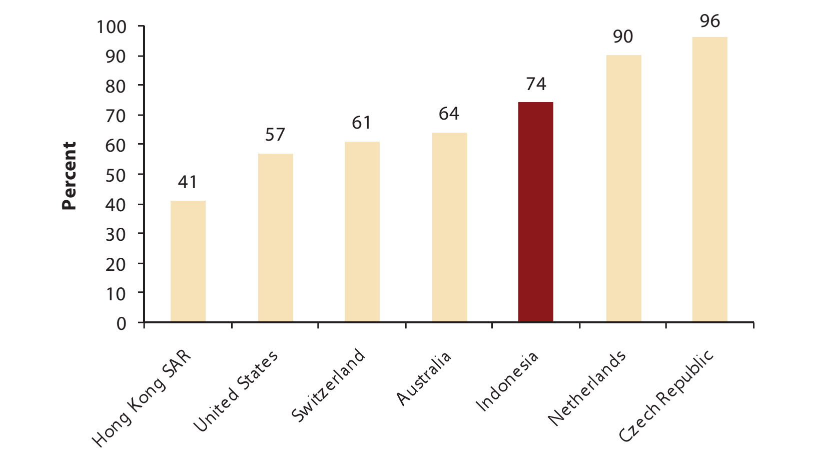
4.1. Teacher Background

4.1.1. Teacher Education Level

Most teachers in the sample had some form of training in mathematics and had achieved a four-year degree. As far as educational background in mathematics is concerned, 87% of the teachers in the sample had some form of training in mathematics (either through a degree or mathematics certificate); 13% did not have a mathematical background. As for the teachers' highest level of education, 3% of the teachers were educated up to D2 level (a two-year college degree), 13% to D3 (a three-year college degree), and 80% to S1/D4 (a four-year college degree), with fewer than 2% of the teachers graduated with an S2 degree.

14 To be precise, the study includes only a representative sample of schools in Indonesia and not a representative sample of Grade 8 mathematics teachers since the teachers were not drawn randomly from the population of teachers in the country.

Figure 4.1 **Educational background of teachers: percent with a mathematics degree**



Source: Indonesia results combined with data from table 2.1 in Hiebert, J. et. al., (2003), page 17

Compared to other countries, a relatively high proportion of Indonesia's teachers had mathematics as their college major. Figure 4.1 below shows the educational background of teachers who were educated at S1 level mathematics or mathematics education or above. As can be seen from the figure, 74% of the teachers in the sample had an S1 diploma in mathematics/mathematics education or above, while the corresponding figures for teachers in the TIMSS 1999 Video Study countries were between 41% and 96%.

4.1.2. Teacher Certification

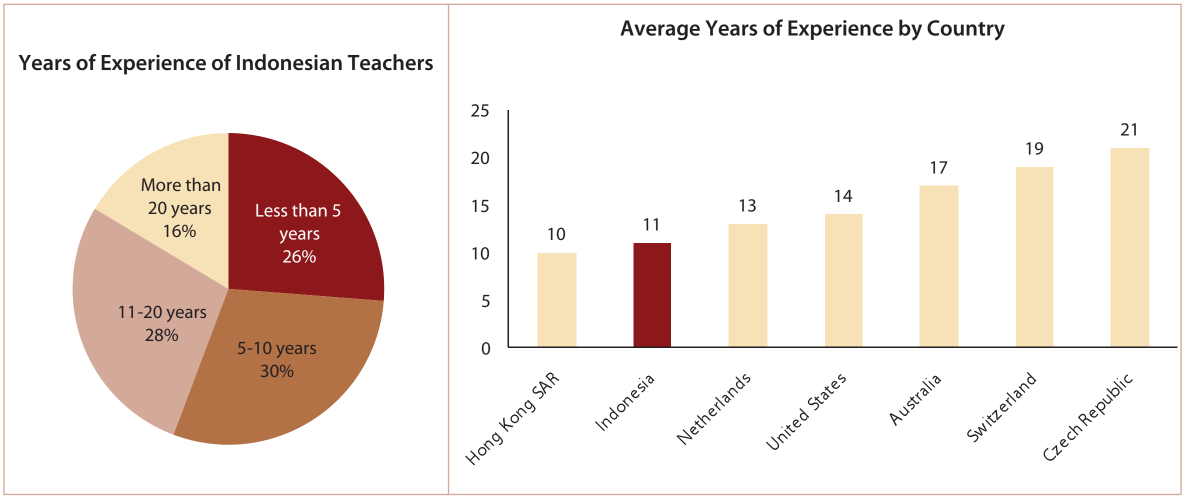
For the 2007 phase of the study, only one teacher in the sample had attained certification; this will be important for comparison with the 2011 phase of the study. In Law No. 14 of 2005 on teachers and lecturers, it is mentioned that the recognition of teachers as professionals is proven with a certificate in education, and teachers in Indonesia will get certified in stages. By the end of 2007, of the approximately 53,000 junior secondary mathematics teachers in Indonesia, 4,425 had been certified (Puspendik, 2008), amounting to approximately 8% of all junior secondary teachers. There were altogether 27 certified mathematics teachers in the sample schools. However, there was only one certified mathematics teacher in the videotaped lessons.

The reason for such a low overall number of certified teachers is that at the time of data collection, Indonesia's new portfolio process for certification had been in place for less than a year. The goal under the Teacher Law is to have all teachers certified by 2015. When the second phase of the video study is conducted in 2011 it is expected that at least half of teachers in the sample will have undergone certification.

4.1.3. Teaching Experience in Mathematics

Indonesia's teachers had relatively fewer years of experience compared to other countries. Teaching experience is one of the aspects that may affect the performance of teachers in their teaching. Some research shows that the longer teachers teach, the more adequate they are in their teaching ability. In this study, only experience in teaching mathematics, rather than general teaching experience in other subject areas, was taken into account. The lengths of teaching mathematics for teachers in the sample varied from 1 year to 32 years. Sixteen teachers (26%) were relatively inexperienced, with fewer than five years of teaching experience. Eighteen teachers (30%) had experience between five to 10 years; 17 teachers (28%), had experience between 11 to 20 years; and 10 teachers (16%) were very experienced, with over 20 years of experience. Figure 4.2 shows the experience of these teachers in teaching mathematics at the junior secondary level. The average Indonesian teacher had been teaching for 11 years (with a median of 10 years), which is much lower than teachers in the other seven countries (the average teaching experience of teachers in the TIMSS 1999 Video Study countries was from 10 to 21 years). The likely reason for Indonesia's teachers being relatively younger is that while the other countries in the study have had universal enrollment at the junior secondary level for many years, Indonesia's junior secondary enrollment is much lower but has been increasing. At this level, the gross enrollment rate was

Figure 4.2 **Years of experience in teaching mathematics and comparison with other countries**



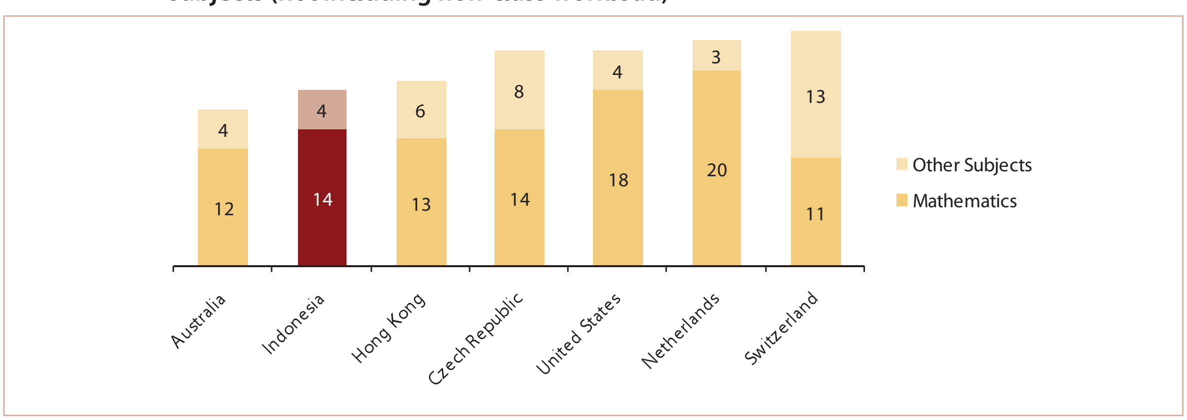
Source: Indonesia results combined with data from table 2.3 in Hiebert, J. et. al., (2003), page 19

only 65.6% in 1995 but reached 82% by 2007. While Indonesia's older teachers tend to work in primary schools, many of the newer teachers tend to have been hired at the secondary school level to meet the demands of increased enrollment.

4.1.4. Teacher Workload

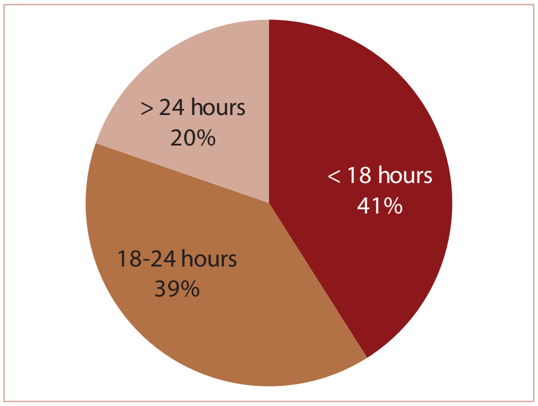
The workload of Indonesia's teachers was relatively low compared to other countries. As for classroom workload, Indonesian teachers on average taught mathematics classes for 14 hours per week while those in other countries ranged from 11 to 20 hours. Teachers in all countries taught multiple subjects, and when taking other subjects into account, teacher workloads in Indonesia increased to 18 hours while in the other countries it increased to between 16 and 24 hours. When taking work outside of the classroom into account, the workloads ranged between 36 and 42 hours per week.

Figure 4.3 **Average class time of mathematics teachers in mathematics class (in hours) vs. other subjects (not including non-class workload)**



Source: Indonesia results combined with data from table 2.4 in Hiebert, J. et. al., (2003), page 20

Figure 4.4 **Number of classroom teaching hours per week in mathematics**



The mathematics teachers in the sample tended to teach only mathematics. Most Indonesian mathematics teachers taught only the subject of mathematics, but there were 12 mathematics teachers in the sample who also taught non-mathematics lessons. The number of hours teaching non-mathematics varied from two to 20 hours. Almost all teachers fall short of the Ministerial Decree (Permendiknas) No. 18 of 2007 that requires that teachers have 24 class periods of mathematics in order to be eligible for the certification bonus (professional allowance).[15] Figure 4.4 indicates that 80% of the teachers in the sample taught fewer than 24 hours per week.

Meanwhile, in Australia, the Czech Republic, Hong Kong SAR, the Netherlands, Switzerland and the United States, the average teaching load is between 36 to 42 hours per week and the number of hours teaching mathematics is between 11 to 20 hours (see Figure 4.3).

4.1.5. Teacher Gender

The teachers participating in the video study were evenly split in terms of gender, with 51% female and 49% male. This is very close to the national average for junior secondary mathematics teachers, with 49% female and 51% male. Interestingly, 60% of female teachers were mathematics majors compared to only 43% of male teachers. There is little difference in terms of years of experience, with female teachers having 12.7 years on average, compared to 13.3 years for male teachers. There is also little difference in terms of civil servant status, with 58% of female teachers being civil servants compared to 60% of male teachers. There is a slight difference in terms of geographic location, with 64% of female teachers working in rural areas compared to male teachers at 69%.

4.2. Lesson Structure

4.2.1. The Duration of the Lessons

There was a large variation in the length of the mathematics classes videotaped in Indonesia. Table 4.1 below shows the duration and other descriptive statistics of the sampled lessons in the study. Indonesia's class length ranged from 39 to 97 minutes, with an average class length of 70 minutes and a standard deviation of 14. The number of minutes of mathematics class per week is estimated to be 140, which is lower than most other countries.

15 Law No. 14 of 2005 states that teachers are only allowed to teach in the subject in which they are certified and that they are only allowed to be certified in one subject. In practice, though, many teachers teach more than one subject.

Table 4.1 **Duration of lessons (in minutes)**

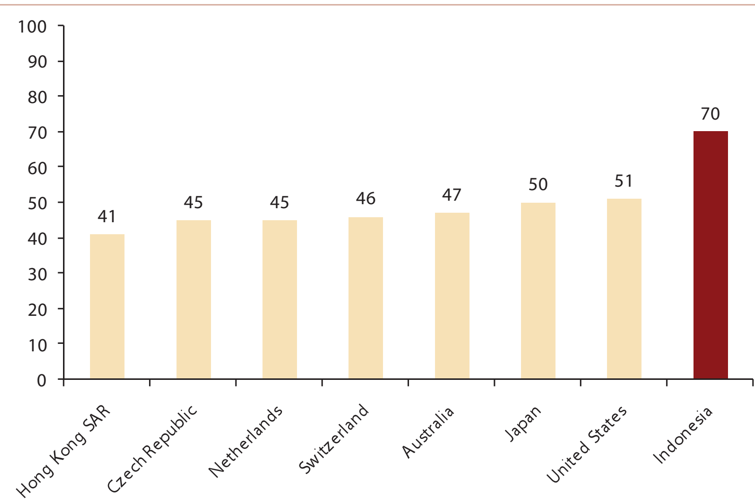
Country	Mean	Median	Minimum	Maximum	Std. Dev.	Est. Minutes/week	2007 hours total
Hong Kong SAR	41	36	26	91	1	175	148
Czech Republic	45	45	1	90	13	179	128
Netherlands	45	45	35	100	7	127	--
Switzerland	46	45	39	65	3	--	--
Australia	47	45	28	90	13	174	131
Japan	50	50	45	55	2	200	105
United States	51	46	33	119	17	179	148
Indonesia	**70**	**68**	**39**	**97**	**14**	**140**	**136**

Source: Indonesia results combined with data from tables 3.1 and 3.2 in Hiebert, J. et. al., (2003), pages 37 and 41; 2007 hours is from the TIMSS 2007 report (Mullis, 2008, exhibit 5.2)

Indonesia's classes were significantly longer than in other countries. The mean duration of 70 minutes for Indonesia was much longer than the average duration of only 41 to 51 minutes in other countries (see Figure 4.5 below). The curriculum calls for four class periods of mathematics per week (with a period being 45 minutes), with the 70 minutes witnessed in the video often being two combined class periods. According to the TIMSS 2007 report, Indonesia's total hours per year is 136, which falls in the middle of the comparison countries. (Mullis, 2008, exhibit 5.2)

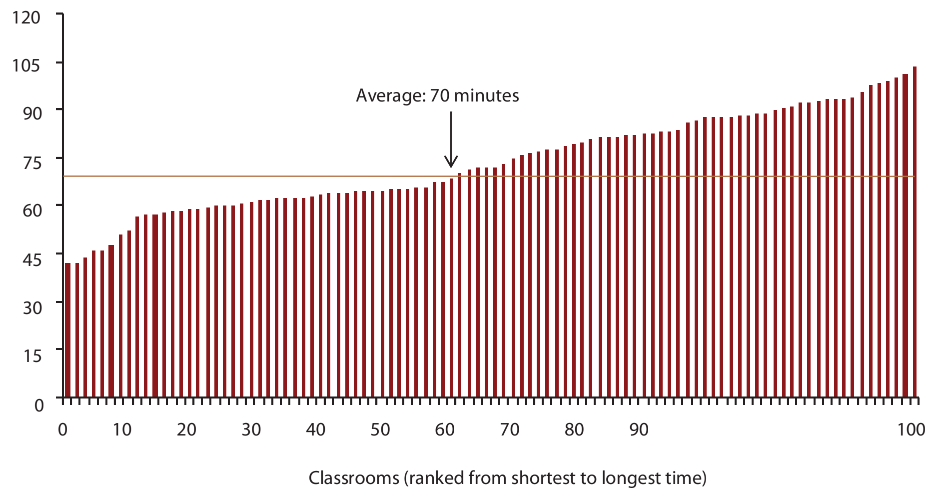
The breakdown of each individual class shows that most classes last at least 1 hour, with 25% extending 1 ½ hours or longer. In examining the classrooms by ranking them from the shortest to the longest classroom time, it can be seen in Figure 4.6 that approximately 30% of classes are an hour or less, with the shortest class being 40 minutes long. The median class time was 68 minutes and the average class was 70 minutes. Over 40% of the classes went beyond one hour and 15 minutes, with eight classes extending beyond the 90 minute mark. While there may be advantages of having longer classes, one area of concern is whether Grade 8 students can maintain an attention span for such an extended period of time.

Figure 4.5 **Length of lessons in mathematics**



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 37
Note: Indonesia's lessons are significantly longer due mainly to the fact that in most schools two class periods are combined into a single session.

Figure 4.6 **Ranking of class length in minutes, from lowest to highest**



4.2.2. Amount of Time Spent Studying Mathematics

The initial layer of analysis broke down class time into mathematics, non-mathematics and mathematics organization time. Following the practice of the TIMSS 1999 Video Study, the time in the recorded lessons was classified according to three kinds of activities: mathematical work, mathematical organization, and non-mathematical work. The TIMSS 2009 Video Study defined these three kinds of activities in the following way:

- **Mathematical work:** Time spent on mathematical content presented either through a mathematical problem or outside the context of a problem; e.g., talking or reading about mathematical ideas, solving mathematical problems, practicing mathematical procedures or memorizing mathematical definitions and rules.
- **Mathematical organization:** At least 30 continuous seconds devoted to preparing materials or discussing information related to mathematics but not qualifying as mathematical work; e.g., distributing materials used to solve problems, discussing the grading scheme to be used on a test or distributing a homework assignment.
- **Non-mathematical work:** At least 30 continuous seconds devoted to non-mathematical content; e.g., talking about a social function, disciplining a student while other students wait or listening to school announcements on a public-address system.

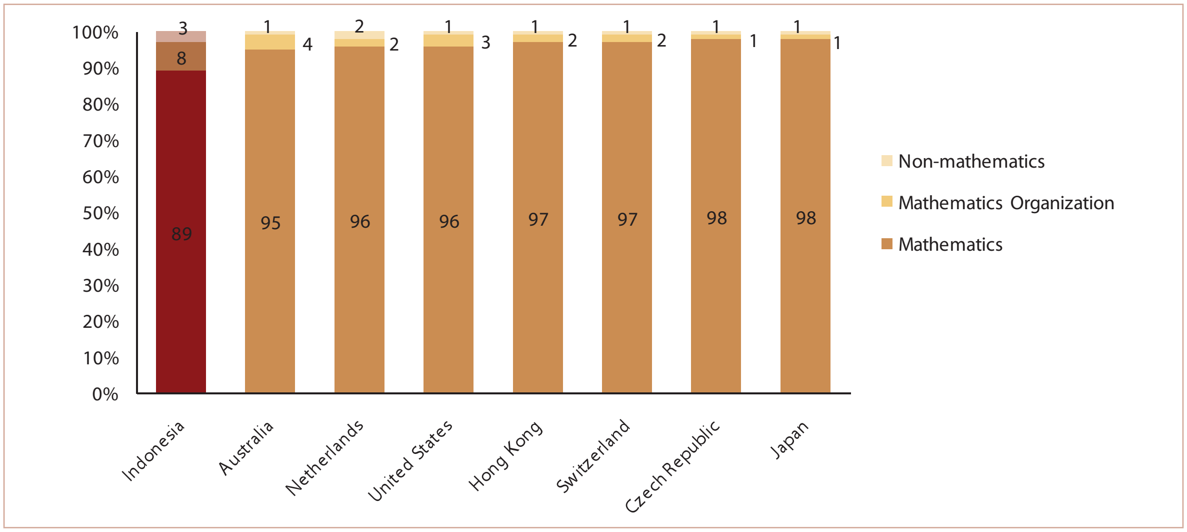
(p. 38 of Hiebert et al, 2003)

The distribution of time for the three kinds of activities was as follows (Table 4.2):

Table 4.2 **Time used for mathematical work, mathematical organization, and non-mathematical work (minutes)**

Structure	% of Time	Mean	Median	Std. Dev.	Minimum	Maximum
Mathematical work	89%	62.2	60.9	14.1	35.0	90.1
Non-mathematical work	3%	1.8	1.3	1.6	0.2	10.9
Mathematical organization	8%	5.8	4.9	4.0	0.4	18.8

Figure 4.7 **Percentage of time used for learning mathematics**



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 39

Indonesia's classes tended to have a much larger proportion of non-mathematical and mathematical organization time. The bar chart in Figure 4.7 below shows the percentages of the average duration of the three kinds of activities in the recorded lessons. It can be seen that mathematical activities took up 89% of the time (3734 of the 4188 seconds), while non-mathematical activities and organization activities took up 3% and 8% of the time respectively. Compared with other countries where the time used for mathematical activities ranged from 95% to 98%, the time that was used for mathematical work in Indonesia was lower. In contrast, the percentage of time used for mathematical organization work was higher.

4.2.3. The Role of Mathematical Problems

a. Time spent on problems and non-problems

Mathematics time can be further broken down into segments of either working on problems or non-problem time. Time spent on mathematical work (89% of class time in Indonesia) was divided into either *problem* or *non-problem* time. The definition of this time is as follows:

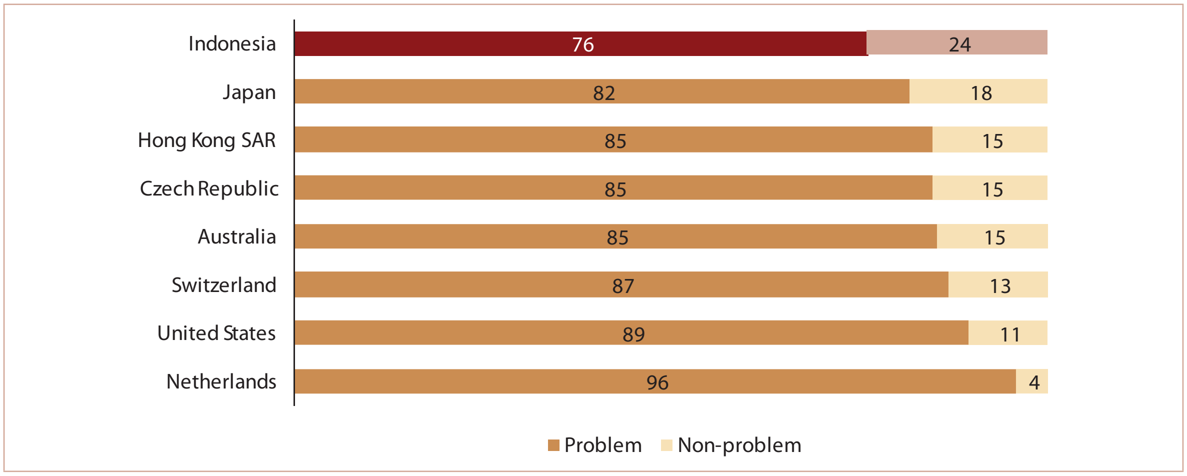
Working on problems: Problems are defined as events that contain a statement asking for some unknown information that can be determined by applying a mathematical operation. Simple questions asking for immediately accessible information were not counted as problems. Examples of mathematical problems include:

- Adding, subtracting, multiplying and dividing whole numbers, decimals, fractions, percents and algebraic expressions
- Solving equations
- Measuring lines, areas, volumes and angles
- Plotting or reading graphs
- Applying formulas to solve real-life problems

Non-problem segments: A non-problem segment is defined to be mathematical work outside the context of a problem. Without presenting a problem statement, teachers (or students) sometimes engaged in:

- Presenting mathematical definitions or concepts and describing their mathematical origins

Figure 4.8 Mathematical time divided into Problem vs. Non-Problem Segments (percent of total)



Source: Indonesia results combined with results from Hiebert (2003) using graph from page 42, but modified to only include mathematical time.

- Giving an historical account of a mathematical idea or object
- Relating mathematics to situations in the real world
- Pointing out relationships among ideas in the lesson and previous lessons
- Providing an overview or a summary of the major points of the lesson
- Playing mathematical games that did not involve solving mathematical problems (e.g., a word search for mathematical terms).

Indonesia spent a significantly larger proportion of time on non-problem segments. The results in Figure 4.8 show that of the time classified as *mathematics time,* Indonesia spends much more time on non-problem segments than in other countries, with 76% dedicated to problem work and 24% to non-problem time.

b. Independent problems

Most of the lesson time in Indonesia, as in other countries, was spent on solving mathematical problems, either by the teacher or by the students. The TIMSS 1999 Video Study classified mathematical problems into three types according to the setting in which they were solved. Here we focus only on one type, called independent problems, which were defined as those presented as single problems and worked on for a clearly definable period of time. These problems might have been solved publicly — as a whole class — or they might have contained a private work phase when students worked on them individually or in small groups. (Hiebert, 2003, p.43)

Most classes had only two independent problems per lesson, with an average of 3.3 problems. The number of independent problems solved over the course of each videotaped lesson varied from one to 10 (as shown in Figure 4.9).

The average time used to solve one independent problem was 6.5 minutes (393 seconds). The shortest independent problem was solved in only 3 seconds while the most time-consuming one took 14.5 minutes (873 seconds).

In comparison with other countries, Indonesia had fewer independent problems but spent more time in solving them. Figure 4.10 shows Indonesia compared to other countries. On one extreme, Japan averaged

Figure 4.9 **Number of independent problems solved in the lessons**

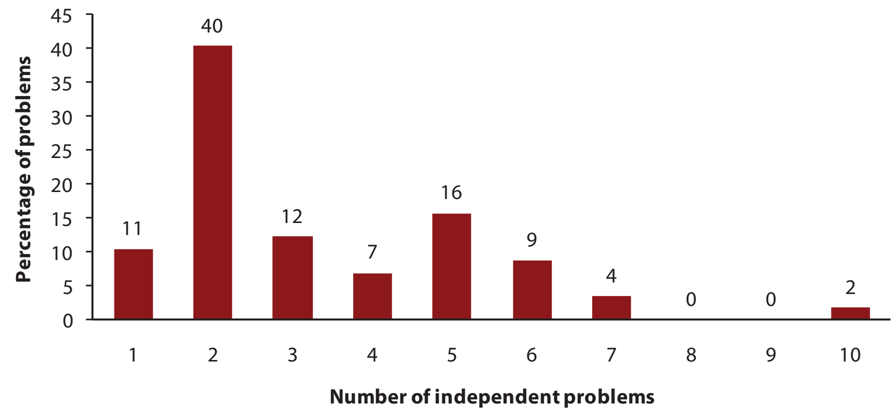
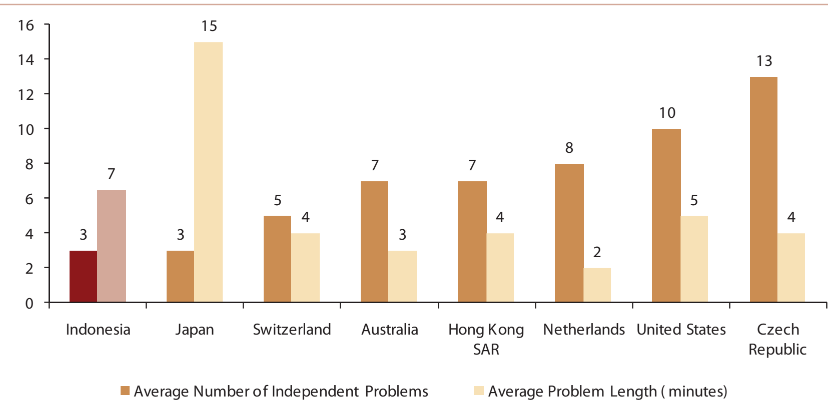


Figure 4.10 **Average number of independent problems solved in the lesson and average length of time in minutes**



Source: Indonesia results combined with results from Hiebert (2003) using table 3.3 on page 44 and figure 3.5 on page 46

three independent problems per lesson but spent 15 minutes per problem. On the other extreme, the Czech Republic had 13 independent problems per lesson and spent only four minutes per problem on average. Only Japan spent more time per independent problem.

c. Problem solved in more than 45 seconds

Most of the problems in Indonesia took longer than 45 seconds to solve. The length of time used to solve a problem is also an indication of the complexity of the problem. The average number of problems that was completed in more than 45 seconds was 4.8 which constituted 65% of all the independent problems.

4.2.4. Time Used to Review, Learn New Content, and Practice

All mathematics time can also be broken out into segments based on their purpose.

Reviewing: This category, more technically called "addressing content introduced in previous lessons," focused on the review or reinforcement of content presented previously. These segments typically involved the practice or application of a topic learned in a prior lesson or the review of an idea or procedure learned previously. Examples included:

- Warm-up problems and games, often presented at the beginning of a lesson
- Review problems intended to prepare students for the new content
- Teacher lectures to remind students of previously learned content
- Checking on the answers of completed homework problems
- Quizzes and grading exercises

Introducing new content: This category focused on introducing content that students had not worked on in an earlier lesson. Examples of segments of this type included:

- Teacher expositions, demonstrations, and illustrations
- Teacher and student explorations through solving problems that were different, at least in part, from problems students had worked previously
- Class discussion of new content
- Reading textbooks and working through new problems privately

Practicing new content: This category focused on practicing or applying content introduced in the current lesson. These segments only occurred in lessons where new content was introduced. They typically took one of two forms: (i) the practice or application of a topic already introduced in the lesson, or the follow-up discussion of an idea, or (ii) follow-up discussion after the class engaged in some practice or application. Examples of segments included:

- Working on problems to practice or apply ideas or procedures introduced in an earlier lesson
- Class discussions of problem methods and solutions previously presented
- Teacher lectures summarizing or drawing conclusions about the new content presented earlier

Assessment: This category focused on students being measured on their understanding of the mathematics content in a formal way that wouldn't be considered simply practicing. Examples of segments included:

- Quizzes
- Formal tests

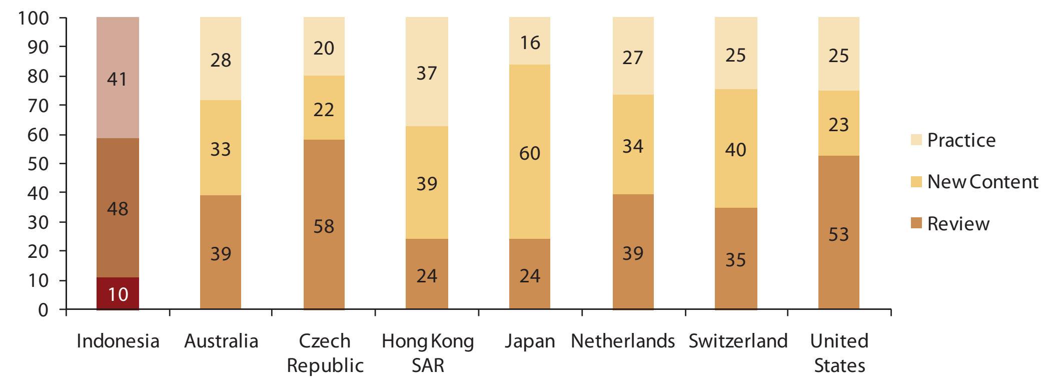
The most common use of time was introducing new content, but each purpose type had a great deal of variation. The average time used for review, new content, practice and assessment is shown in Table 4.3 below. The average time used to practice in class was 24.4 minutes or 34% of classroom time. New content was 30.8 minutes (43%), review was 7.2 minutes (10%) and assessment was 1.2 minutes (1.6%).

Indonesia spent relatively less time in review and more time in practice than other countries. In comparing these numbers to other countries, it can be seen in Figure 4.11 that Indonesia's 10% for *review* was significantly lower than in other countries. The next lowest percentage was 24% for Hong Kong and Japan, while the Czech Republic dedicated 58% of classroom time to review on average. In *practice*, on the other hand, Indonesia dedicated relatively more time, with 37%. Hong Kong was the highest at 37%, while Japan was the lowest at only 16%. For *new content*, Indonesia fell in the middle with 43%.

Table 4.3 Time (in minutes and seconds) used for review, new content, practice and assessment

Mathematical Activities	Mean	Median	Std. Deviation	Minimum	Maximum	N
Review	7.2	4.6	9.2	0.3	50.4	60
New content	30.8	28.7	20.5	4.7	85.4	64
Practice	24.4	25.2	18.5	1.2	75.9	61
Assessment	1.2	0	3.4	1	15.7	10

Figure 4.11 Duration for different activities in Indonesia and other countries



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 50
Note: *"Practice" is made up of the "practice" and "assessment" categories. If the "assessment" portion is not included, then the breakdown would be 12% "review", 48% "new content" and 40%"practice".*

4.2.5. Classroom Interaction

a. Public (full-class) and private (small group and individual) interaction

An important distinction in the use of class time is in the type of interaction, with public (full-class) and private (individual or group) work. The TIMSS 1999 Video Study defined public and private interactions in the following way:

- **Public interaction:** Public presentation is made by the teacher or one or more students intended for all students.
- **Private interaction:** All students work at their seats, either individually, in pairs or in small groups, while the teacher often circulates around the room and interacts privately with individual students.[16]

Indonesia was in the middle compared to other countries in terms of public vs. private interaction, with 57% of class time being public and 43% private. As shown in Figure 4.12 below, Hong Kong SAR was at one extreme, with 80% of class time being public interaction, and the Netherlands was at the opposite extreme, with only 44%.

The public and private interaction can also be broken down by segment lengths, meaning the amount of uninterrupted time for a given interaction. Table 4.4 contains the segment length for time used in public interaction and private interaction. It shows that the average time used for private interaction was 9.22 minutes, with an average of four segments in a lesson, and that for public interaction was 6.67 minutes, with an average of 3.6 segments.

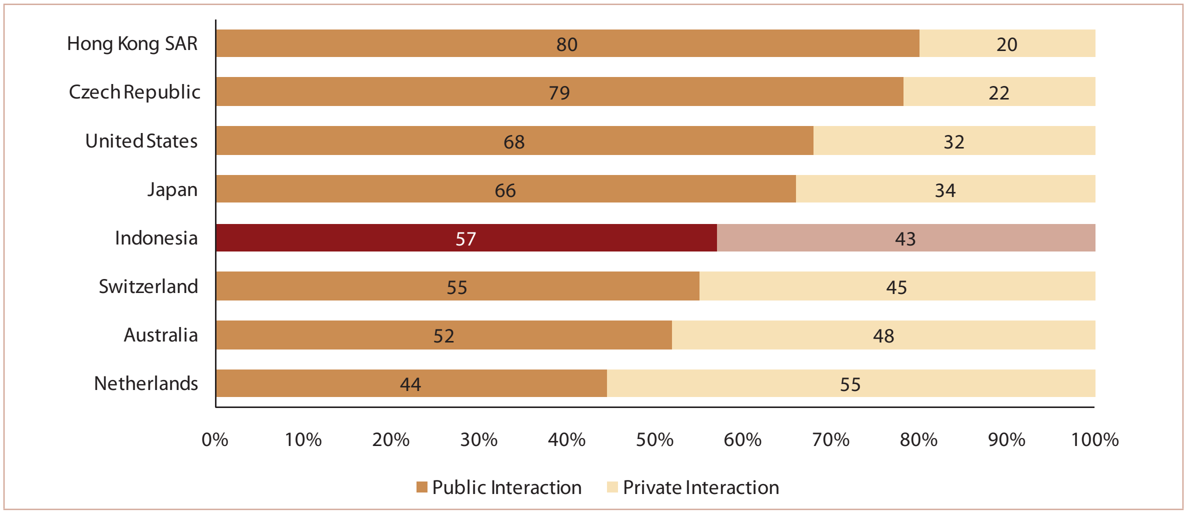
Table 4.4 Segment length (in minutes) for public interaction and private interaction

Interaction	Mean	Median	Std. Deviation	Minimum	Maximum	Avg. Segments
Private interaction	9.2	6.2	9.2	0.2	60.7	4.0
Public interaction	6.7	4.0	7.4	0.1	55.2	3.6

Note: lessons are made up of multiple segments as the class switches from one type of interaction to another.

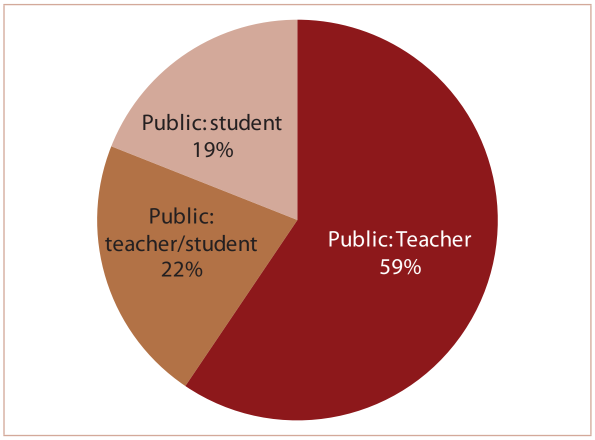
16 (Hiebert et al, 2003 , pp. 53-54)

Figure 4.12 **Percentage of time for public interaction and private interaction**



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 54

Figure 4.13 **Public interaction breakdown: teacher and student involvement**



Note: Percent is calculated by taking the average percentage of time in each individual lesson rather than taking a cumulative time from all lessons.

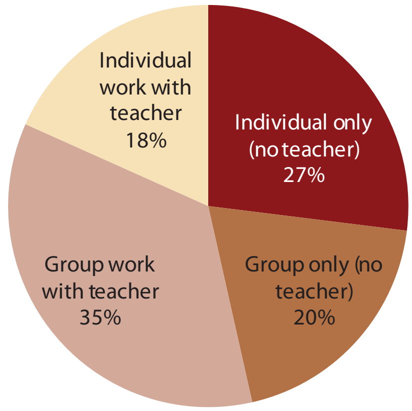
b. Public Interaction: teacher and student participation

Of public interaction time, the majority was teacher-only (lecture) interaction. Public interaction can further be broken down into teacher-only, teacher-student and student-only time. This breakdown is shown in Figure 4.13 below. As would be expected, the teacher-only (lecture) was the most common form of public interaction, making up 59% of all public interaction. Student-only time made up 19%, with the remaining 22% involving both the teacher and students.

c. Private Interaction: group work and individual work

Private interaction was fairly evenly separated between group and individual time. As pointed out above, private interaction included time when students were either working individually or in small groups. Here we define "group work" as activities where students work or discuss in small groups, either with or without the guidance of the teacher, and "individual work" as activities where individual students are working alone, either with or without the teacher assisting individual students. As shown in Figure 4.14 below, group work was more common, making up 55% of total individual interaction. The teacher was typically involved in this form of activity, visiting groups as they worked.

Figure 4.14 **Private interaction breakdown: time used for group work and individual work**



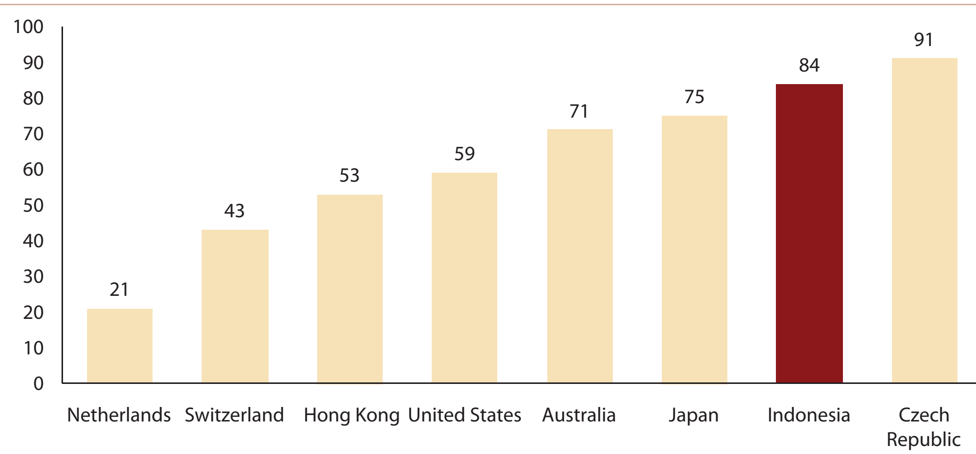
4.2.6. Pedagogical Features that Influence Lesson Clarity and Flow

Techniques to improve the clarity and flow of lessons can assist students in learning. One way to enhance the clarity and the flow of the lesson is for the teacher to make goal statements about the lesson (at the beginning of the lesson and at appropriate points in the lesson) and to summarize the lesson from time to time. On the other hand, outside interruptions disrupt the flow of the lesson. These factors will be examined in this section.

a. Goal statements

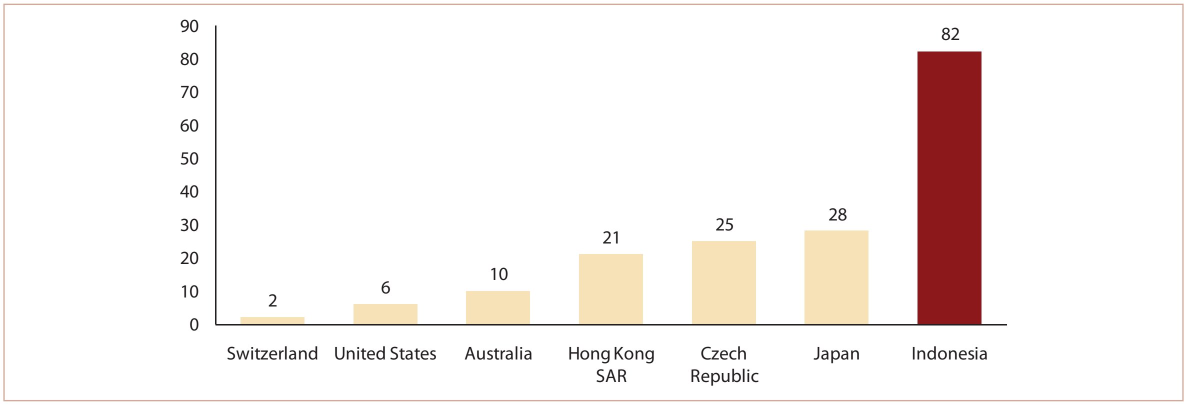
Indonesia used goal statements more frequently than most other countries. Goal statements "can help students identify the key mathematical points of a lesson" (Brophy, 1999, quoted in Hiebert, 2003, p.59) and thus should be helpful in achieving the learning goal of the lesson. Figure 4.15 below shows the percentages of lessons which included at least one goal statement in Indonesia and other countries. In 84% of classes a goal statement was used, which was much higher than most countries; only the Czech Republic had a higher percentage.

Figure 4.15 **Percent of lessons which included at least one goal statement**



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 60

Figure 4.16 **Percent of lessons which include at least one summary statement**



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 61
Note: The Netherlands was not included because reporting standards were not met; too few cases were reported.

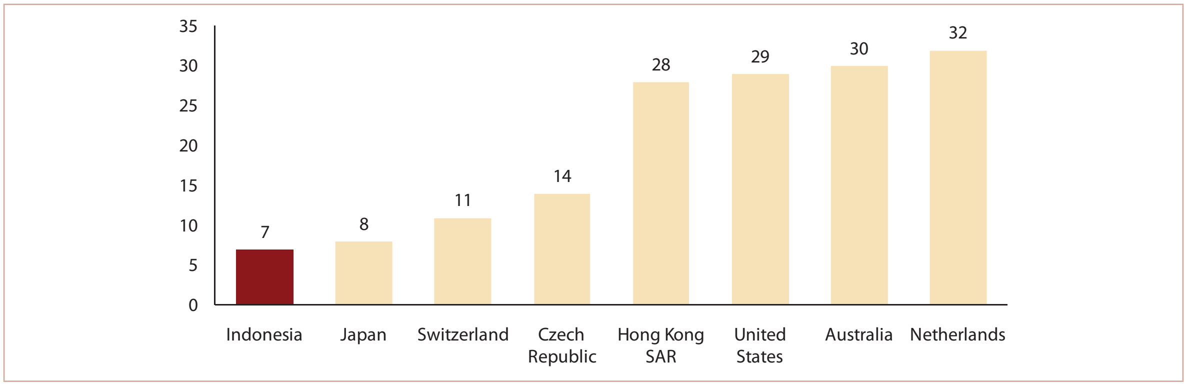
b. Summary statements

Indonesia used summary statements much more frequently than all other countries. Summary statements highlight points that have just been covered in the lesson and are helpful for students to recognize the key ideas in a lesson (Hiebert, 2003, p.60). In Indonesia, it was found that some 82% of the mathematics lessons contained at least one summary statement (see Figure 4.16 below). This was much higher than in other countries, with Japan being the next closest at 28%. In teacher training, Indonesian teachers are taught to use a summary statement, and it appears that most teachers follow this training.

c. Outside interruptions

Indonesia's classrooms had many fewer interruptions than in other countries. Outside interruptions include announcements over the speaker or intercom system, people who want to meet the teacher or the students, teachers talking to students who come late and other outside disruptions that break the flow of the classroom activity. These events, which often happen during a lesson, disrupt the lesson and distract the teacher and the students from concentrating on the teaching and learning. However, in this study it was found that only 7% of the Indonesian lessons had interruptions recorded. As can be seen in Figure 4.17 below, Indonesia had the lowest percent of classes with interruptions.

Figure 4.17 **Percent of lessons with at least one interruption from outside**



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 62

4.3. Lesson Content

Mathematics is a universal science that underlies the development of modern technology and has an important role in many disciplines. In particular, growth in the field of information and communication technology has matured through the development of mathematics. To construct and control future technologies, therefore, requires an early and strong grasp of mathematics.

The subject of mathematics needs to be taught to all students from primary school in order to encourage logical thinking and enhance their analytical, systematic, critical, creative and co-operative abilities. Mathematics competence enables students to obtain, manage and utilize the information needed to survive in conditions that are always changing, uncertain and increasingly competitive.

Given current trends in development, especially in regard to new technologies, students are expected to have competencies in mathematics that are required to meet these demand. These competencies will be obtained if the students reach the goals of learning mathematics that are stated in the Appendix to the *Regulation of the Minister of National Education (Permendiknas), No. 22, Year 2006,* about Standards of Content. The subject of mathematics aims for students to have the ability to:

- Understand the concepts of mathematics, explain the relevance of concepts and apply the concepts or algorithms in a flexible, accurate, efficient and precise way in problem-solving
- Use reasoning patterns and nature to manipulate mathematical generalizations to make, prepare evidence about, and explain ideas and statements in mathematics
- Solve problems that include the ability to understand a problem, design and complete a mathematical model to solve it and interpret the solution obtained
- Communicate ideas with symbols, tables, diagrams or other media to clarify the situation or problem
- Appreciate the purpose of mathematics in life and have both curiosity about and interest in learning mathematics, with an attitude of trust and confidence in problem-solving.

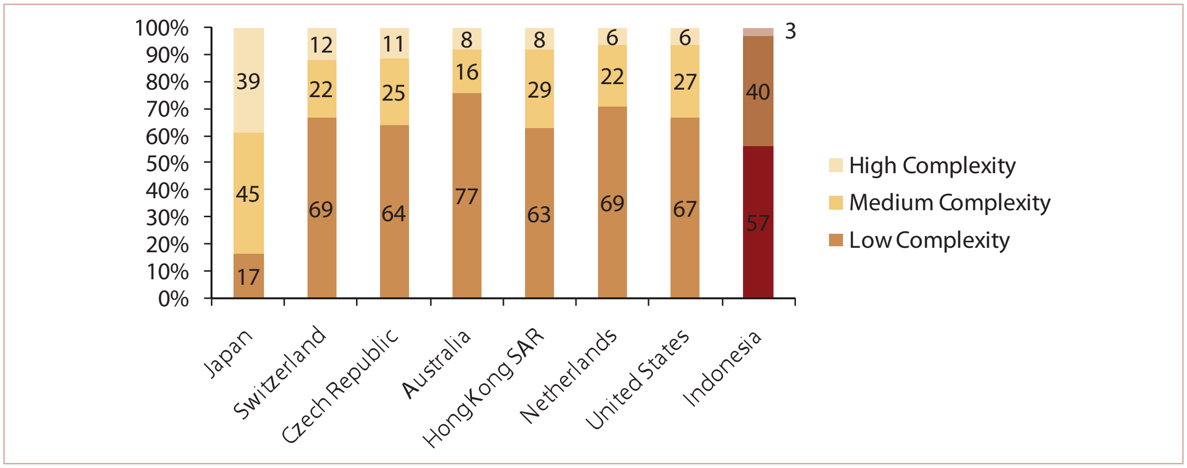
The Standards of Contents indicate that the applicable curriculum is *Kurikulum Tingkat Satuan Pendidikan* (KTSP) or the curriculum of the appropriate education level – namely, the curriculum developed by the individual school following specific MONE guidelines. This ensures that the curriculum will be relevant to the students' needs in meeting the above-mentioned demands of a changing world.

4.3.1. Level of Mathematics Evident in the Lessons - Complexity of the Problems

Students work on problems of various levels of complexity. Following the practice of the TIMSS 1999 Video Study, this study divided the complexity of each problem into three categories: low, moderate and high complexity. These categories were defined as follows:

1. **Low complexity:** problems which require four steps or less to solve using the usual or conventional procedure *(example: solve* $2x + 7 = 2$*)*
2. **Medium complexity:** problems which need more than four steps to solve and which include one sub-problem *(example: solve the system of equations* $2y = 3x - 4;\ 2x + y = 5$*)*
3. **High complexity:** problems which need more than four steps to solve and which include two or more sub-problems (*example: graph the following linear inequalities and find the area of intersection:* $y \leq x + 4;\ x \leq 2;\ y \geq -1$)

Figure 4.18 Level of complexity of problems



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 71

The complexity of problems depends on the ability of the students as well as the skill of the teacher. Teachers will likely choose to give easier problems to students of lower ability. It may also be the case that teachers who have lower competency in mathematics will tend to avoid higher complexity problems.

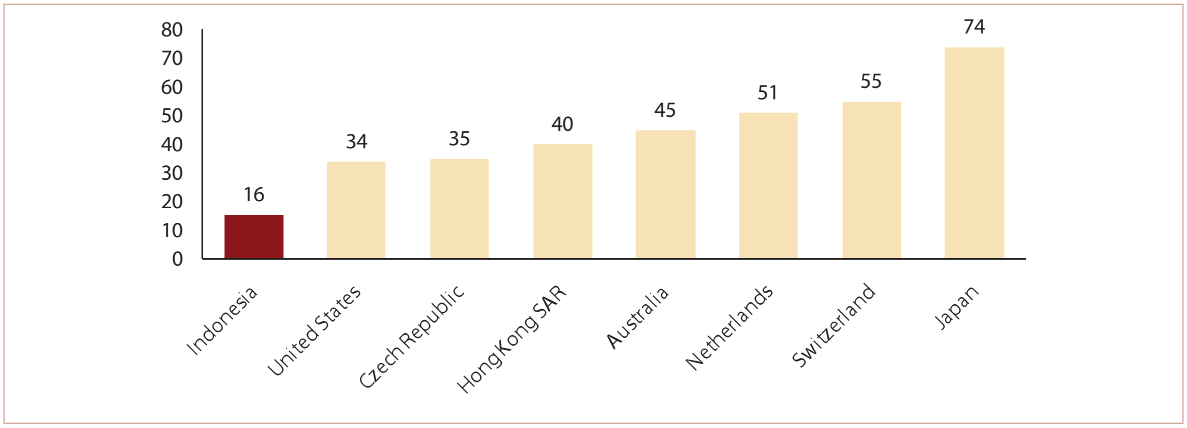
Indonesian classrooms in the study presented very few problems of high complexity but had a large proportion of problems with medium complexity. Figure 4.18 shows how the problems solved in the classrooms of Indonesia compared to other countries. Low complexity problems ranged from 17% to 77%, with average, medium complexity problems between 22% and 45%, and high complexity problems between 6% to 39%. The problems solved in Indonesian classrooms were generally of lower complexity, with the average percentage of low complexity level problems being 57% and of medium complexity 40%, with only 3% of the problems being of high level complexity. The fact of Indonesia having a lower percentage of high complexity problems may be expected since the other countries are economically advanced relative to Indonesia. An unexpected result is that Indonesia had only 57% of problems of low complexity with most countries having a larger percentage. Only Japan had a lower percentage, at 17%.

4.3.2. Type of Mathematics Evident in the Lessons - Problems with Proofs and Applications

Working on mathematical problems can take a variety of forms. As pointed out by Hiebert et al (2003), exercises are a simple approach where students are taught a particular procedure and then asked to practice that procedure using similar problems. A more advanced approach is what are called applications, where students are asked to apply procedures they have learned in one context in order to solve problems presented in a different context.

Indonesia had very few problems that involved applications. Applications often are presented using verbal descriptions, graphs or diagrams rather than just mathematical symbols. They are important because they require students to make decisions about how and when to use procedures they may have already learned and practiced. In this sense, applications are, by definition, more conceptually demanding than routine exercises for the same topic. Figure 4.19 below shows that the percentage of problems which included applications in Indonesia was 16% compared to 34% to 74% in other countries.

Figure 4.19 **Average percentage of problems per Grade 8 mathematics lesson that were applications**

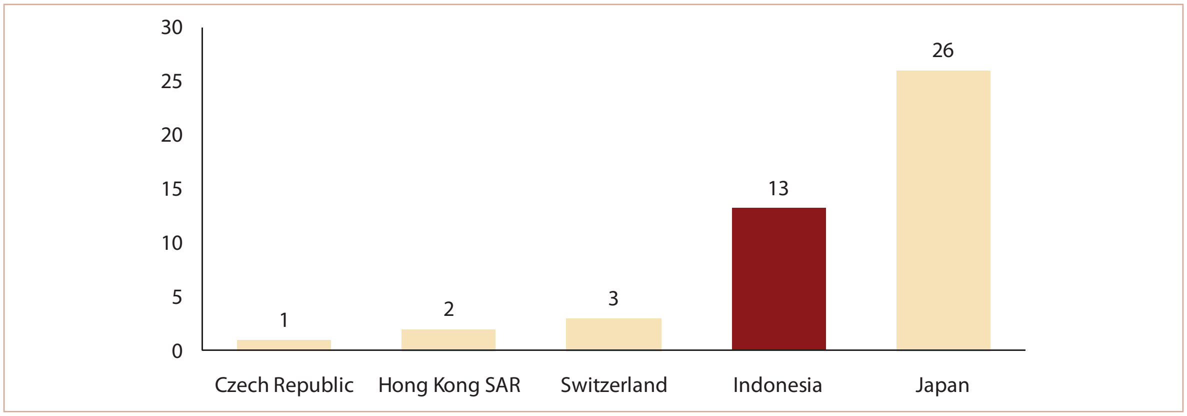


Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 91

The National Research Council has noted that one feature that distinguishes mathematics from other school subjects is the special forms of reasoning that can be involved in solving problems (National Research Council, 2001). One kind of problem that requires special reasoning is a mathematical proof. To prove that something is true in mathematics means more than inferring it is true by checking a few cases. Rather, it requires demonstrating, through logical argument, that it must be true for all cases. Use of proofs in mathematics teaching has been recommended as an important aspect of elementary and middle school mathematics (National Council of Teachers of Mathematics 2000; National Research Council 2001).

The use of proofs was relatively more common in Indonesia than in other countries that participated in the video study. The results in Figure 4.20 indicate that 13% of problems included proofs, compared to the 1% to 26% in other countries.

Figure 4.20 **Average percentage of problems per Grade 8 mathematics lesson that included proofs**



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 74
Note: Australia, the Netherlands, and the US were not included because reporting standards were not met; too few cases were reported.

4.4. Instructional Practices

4.4.1. Teaching Strategies

Teaching strategies employed by teachers are an important insight into how students learn to solve problems. In analyzing the teaching strategies used in the sampled mathematics lessons, the following strategies were coded:

- **Exposition:** The teacher lectures while students listen and answer closed questions (with no discussion).
- **Discussion:** The teacher and student(s) discuss their own ideas about mathematics.
- **Problem-solving:** The teacher provides a problem/situation as a basis to discuss ideas in mathematics.
- **Practical work:** Equipment or situations in the real world are used to explore ideas in mathematics.
- **Investigation:** Students explore the issues (problems) in various mathematical situations.

By far the most common teaching strategy utilized was exposition. Figure 4.21 shows the percentages of mathematics time used for the various activities in mathematics, with 51% on average being dedicated to exposition, 21% to problem-solving, 15% to discussion and 11% to practical work. Only 2% of the time was dedicated to investigation.

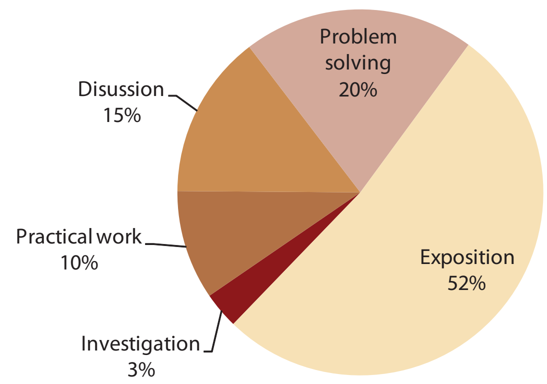
4.4.2. How Mathematical Problems Were Presented and Solved

a. Mathematical processes suggested by problem statements

A different perspective that can be applied to the presenting and solving of mathematical problems is to compare the nature of the problem statements with the way in which the problems are publicly solved. Heibert et al divided the statements of mathematical problems into three types: using procedures, stating concepts, and making connections. This analysis was applied to all independent and concurrent problems for which a solution was reached publicly. The category definitions for each are:

- ***Using procedures*** -- problem statements that suggest the problem is typically solved by applying a procedure or set of procedures. These include using arithmetic with whole numbers, fractions and decimals; manipulating algebraic symbols to simplify expressions and solve equations; finding areas and perimeters of simple plane figures, and so on. Problem statements such as "solve for x in the equation 2x + 5 = 6 - x" were classified as using procedures.

Figure 4.21 **Time for different learning activities in mathematics lessons**



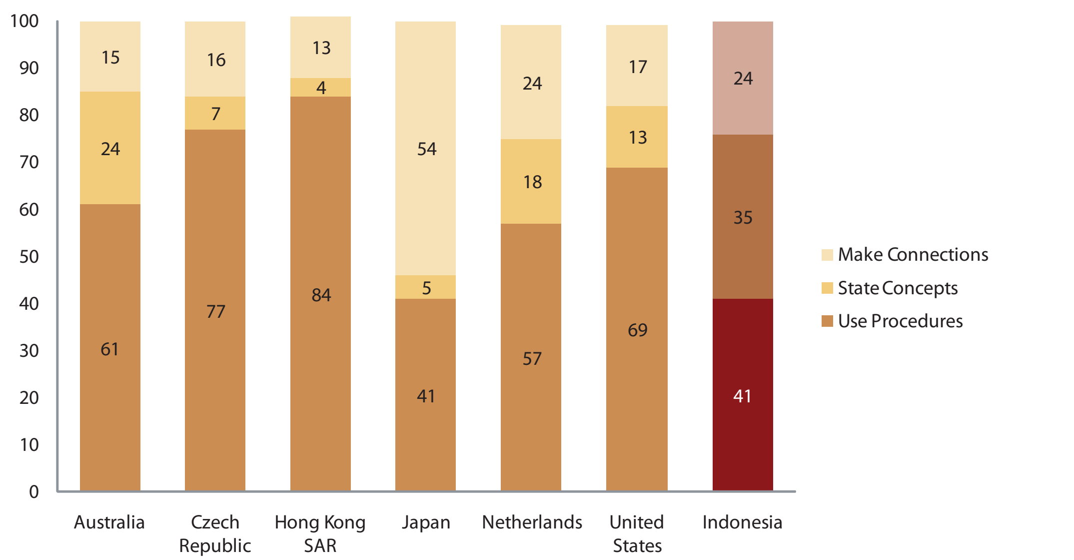
- ***Stating concepts*** -- problem statements that call for a mathematical convention or an example of a mathematical concept. Problem statements such as "plot the point (3, 2) on a coordinate plane" or "draw an isosceles right triangle" were classified as stating concepts.
- ***Making connections*** -- problem statements that imply the problem will focus on constructing relationships among mathematical ideas, facts or procedures. Often such a problem statement suggests that students will engage in special forms of mathematical reasoning such as conjecturing, generalizing, and verifying. Problem statements such as "graph the equations y = 2x + 3, 2y = x - 2, and y = -4x, and examine the role played by the numbers in determining the position and slope of the associated lines" were classified as making connections.

Relative to other countries, Indonesian teachers stated concepts more for problems while they used procedures less frequently. When comparing Indonesia to other countries, it can be seen in Figure 4.22 that Indonesia stated concepts much more often than in other countries, with 35% compared to between 5% and 24%. Indonesia made relatively less use of procedures with only 41% and made connections relatively frequently with 24%.[17]

b. Problems related to the real world and using mathematical language and symbols only

Indonesian teachers tended to use the problem context of real-life situations relatively less often than in other countries. The average percentage of problems involving a real world context was 12% while that in other countries was between 9% and 42%. On the other hand, 88% of the problems in the Indonesian classroom involved mathematical language and symbols only, compared to 40% to 89% in other countries (Figure 4.23 below).

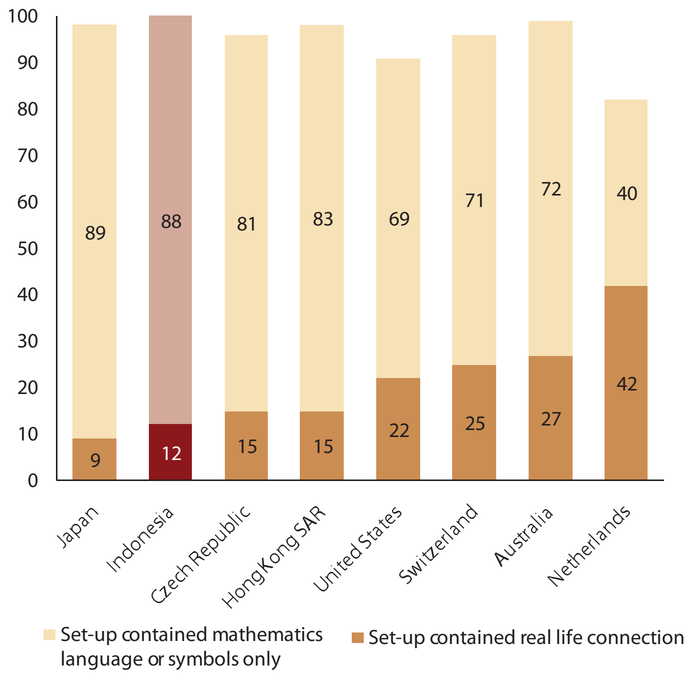
Figure 4.22 Average percentage of problems per mathematics lesson of each problem statement type



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 99

17 Note: The number of problems differs significantly from the amount of time for each type. ***Make connections*** was only 3.6% of the total time while ***state concepts*** was 60% and ***use procedure***s was 35%

Figure 4.23 **Problems related to the real world and using mathematical language and symbols only**



Source: Indonesia results combined with Hiebert, J. et. al., (2003), page 85

c. Problems that include drawing a chart, table or graph.

The use of diagrams in Indonesia was relatively common while graphics and charts were less common. The average number of problems with a diagram was 3.4, which were found in 34 schools (48%). Problems with a table were found only in seven (10%) schools, with an average of 2.7 problems, and problems with graphics and charts were also found in seven (10%) schools with an average of 2.0 problems.

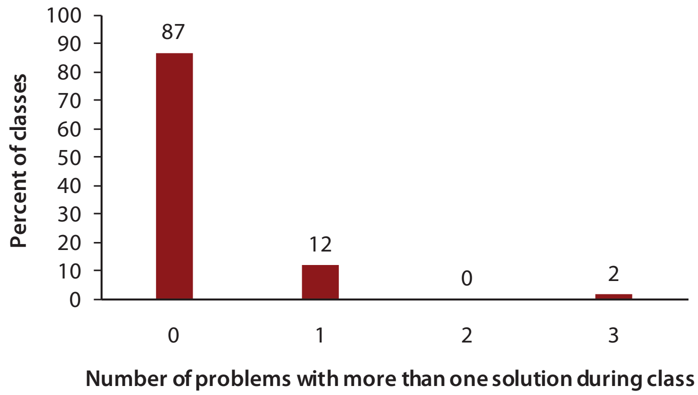
d. Problems using physical tools

The use of physical tools in Indonesia was found in over half the classrooms. Physical tools in mathematics learning include tools for measuring (e.g., rulers, protractors), compasses, visual aids tools, tiles, three-dimensional and two-dimensional geometry models, etc. Essentially, physical tools are tools that can be manipulated by teachers and students. Sixty three percent of the lessons in the sample used physical tools. The average number of problems which required the use of physical tools was 3.7.

e. Problems with more than one solution method

The demonstration of more than one solution method is rarely performed. Mathematics problems often can be solved by using more than one method. If the teacher asks students to find different ways to solve the same problem, the students will become more creative; this will increase students' abilities in reasoning and problem-solving. Figure 4.24 below shows that 87% of the Indonesian lessons did not include problems with more than one solution method. 12% of the lessons contained one problem with more than one solution method, and 2% of the lessons contained three problems with more than one solution method (there were none with two problems).

Figure 4.24 **Percent of classes with a given number of problems with more than one solution method**



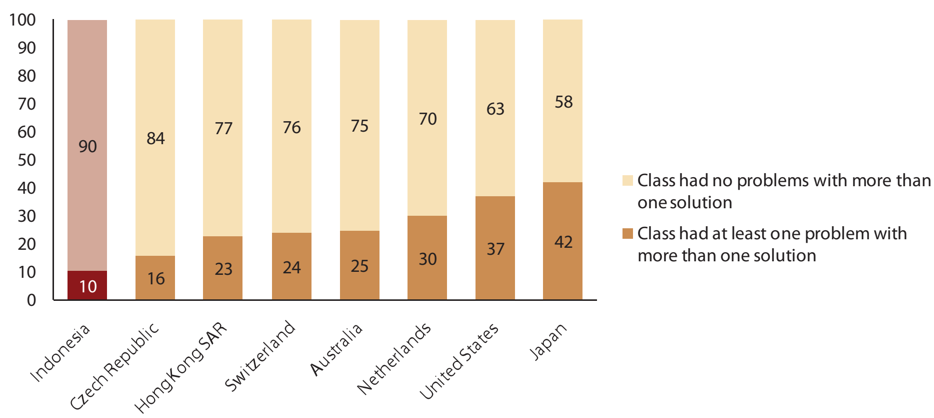
f. The percentage of lessons with at least one problem where more than one solution is presented

Indonesia's results show that the number of problems where more than one solution is presented was lower than in other countries. Figure 4.25 below compares Indonesia's results to other countries. The 10% of lessons with one problem where more than one solution is presented was less than other countries which showed between 16% and 42%.

g. Lessons with examining-methods problems

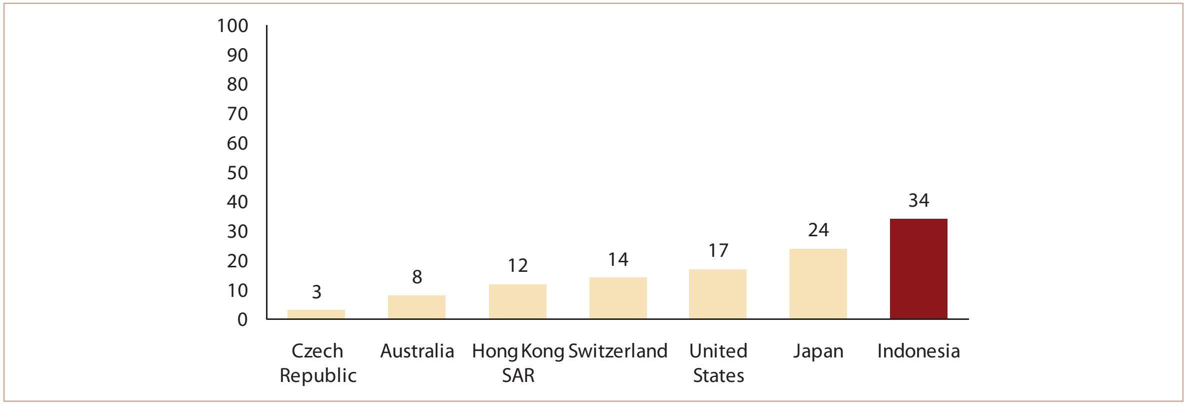
Indonesia had significantly more lessons with at least one "examining-methods" problem than in other countries. Examining-methods problems can include one of these activities: (i) students may choose the solution method; (ii) alternatives of solution methods are presented publicly; (iii) at least one solution method is presented by a student followed by a discussion or criticism of the method, or (iv) there is a comparison of the method with other methods. Results of analysis of the transcripts show that 33.8% of the lessons had examining-methods activities. In comparison to other countries (Figure 4.26), this figure was quite high, with the next closest country only having 24% of lessons with at least one examining-methods problem.

Figure 4.25 **Percent of lessons with at least one problem where more than one solution is presented**



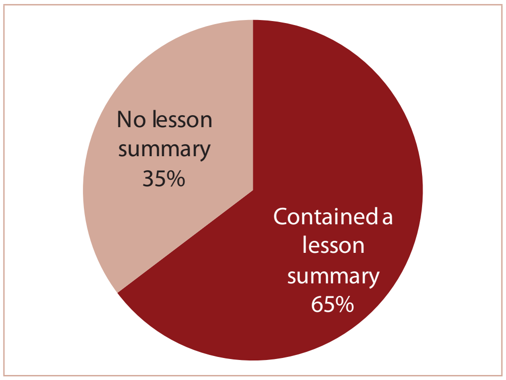
Source: Indonesia results combined with table 5.1 in Hiebert, J. et. al., (2003), page 94

Figure 4.26 **Percent of lessons that contained at least one examining-methods problem**



Source: Indonesia results combined with table 5.3 in Hiebert, J. et. al., (2003), page 96

Figure 4.27 **Percent of lessons that included a lesson summary**



h. Lessons that include summaries

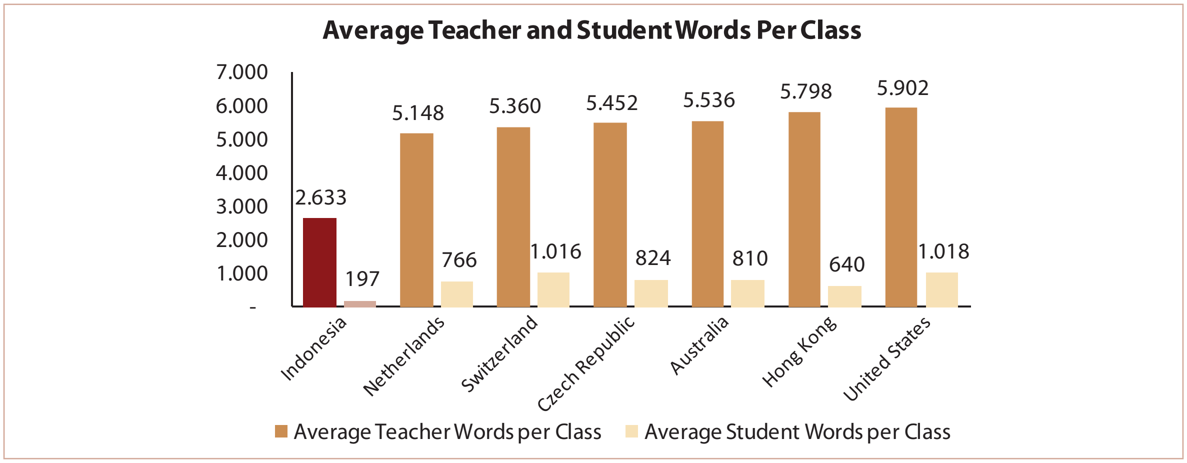
The use of lesson summaries occurred in most classes. Summarizing keys things learned in the lesson is an important teaching and learning activity. The classroom observation and transcript results show that only 65% of the Indonesian lessons contained a summary (Figure 4.27).

4.4.3. Opportunities to Talk

a. Words spoken by teachers and students in each lesson

The number of words spoken by both teachers and students in Indonesia's classrooms was significantly less than in other countries. The average number of words spoken by the teacher in a lesson (standardized to 50 minutes) was 2,633. There were teachers who spoke only 813 words, and there were teachers who spoke up to 5,687 words. In contrast, the average number of words spoken by the students in a lesson was 197. There were lessons where students spoke only an average of eight words per lesson, and there were also lessons where students spoke up to 1,539 words. Although there were many students but only one teacher, the number of words spoken by the teacher was still much more than the number of words spoken by the students. Figure 4.28 below shows the average number of words spoken by the teacher and the students during the lessons compared to other countries. As can be seen, Indonesia's numbers were significantly lower than other countries. For teachers the next lowest country still had more than twice as many words spoken. For students the next lowest had more than three times the words spoken.

Figure 4.28 **Average number of words spoken by the teacher and students during a lesson**



Source: Indonesia results combined with data from figure 5.14 in Hiebert, J. et. al., (2003), page 109

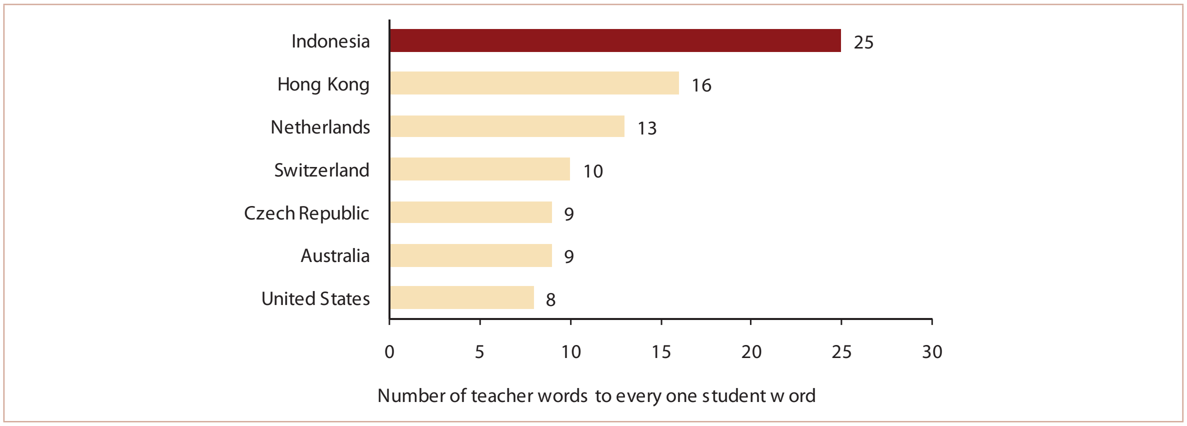
b. Ratio of teachers' words compared to students' words

Indonesia's teachers spoke much more than students, particularly when compared to other countries. The average ratio of the number of words spoken by the teacher to those spoken by the students was 25:1. This means that on average, teachers spoke 25 words while the students spoke one word. The corresponding figures for other countries in the TIMSS 1999 Video Study were 8:1 to 16:1 ((Figure 4.29). Teacher dominance in the classroom was still very evident worldwide, at least in Grade 8 mathematics lessons, but the comparative figures show that students in other countries were far more active than Indonesian students.

c. Words per sentence spoken by the teachers

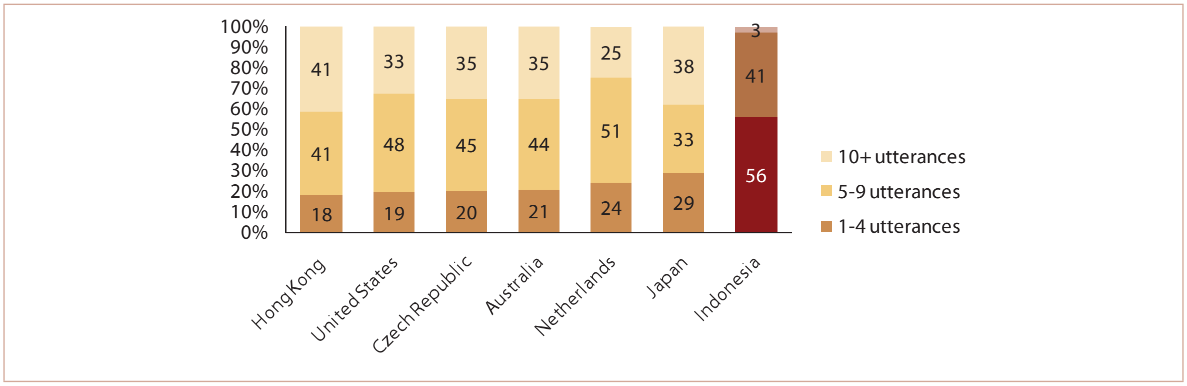
Indonesian teachers rarely spoke in long sentences. Fifty six percent of all sentences spoken by teachers were in the range of 1–4 words, which was much higher than the corresponding figures of 18% to 29% in other countries. For 24 words per sentence or above, the percentage in Indonesia was very small, at 3%, while for other countries it was between 25% and 41% (Figure 4.30). This shows that in Indonesia, teachers rarely spoke in long sentences.

Figure 4.29 **Average number of teacher words to every one student word per lesson**



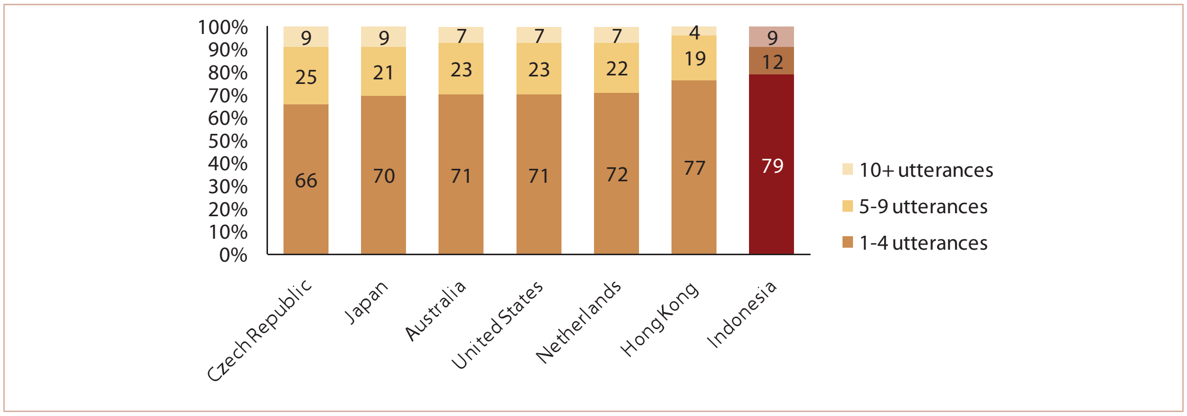
Source: Indonesia results combined with data given in Hiebert, J. et. al., (2003), page 109

Figure 4.30 Average words per sentence spoken by teachers



Source: Indonesia results combined with Figure 5.16 in Hiebert, J. et. al., (2003), page 111

Figure 4.31 Average words per sentence spoken by students



Source: Indonesia results combined with Figure 5.16 in Hiebert, J. et. al., (2003), page 112

d. Words per sentence spoken by students

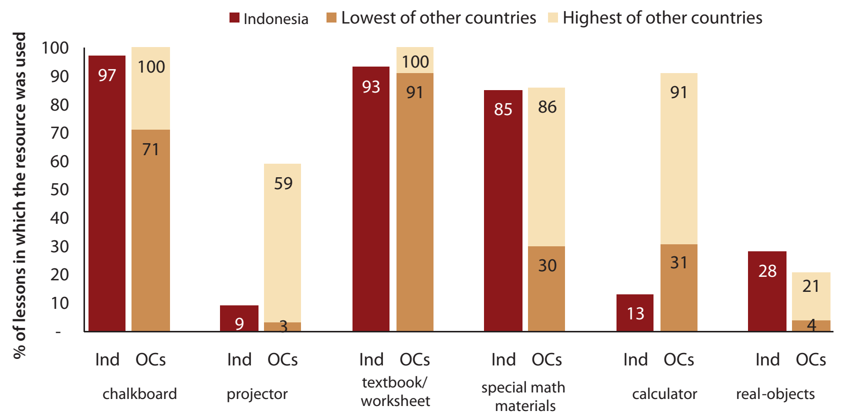
Students also rarely spoke in long sentences. The number of words spoken in one sentence (or a series of words) by students is shown in Figure 4.31 below. In Indonesia, 79% of the students' utterances were in the range of 1–4 words per sentence, while in other countries it varied from 66% to 77%. The number of utterances between 5–9 words in Indonesia was 12%, while in other countries it was between 23% to 34%; and the number of utterances of 9 words or above in Indonesia was 9%, compared to 4% to 9% in other countries. So we can see that the Indonesian students, like their teachers, rarely spoke in long sentences.

4.4.4. Resources Used During the Lesson

a. Tools and resources used

The tools used by teachers provide insights into how teaching practices are conveyed. The resources used during the lesson can include chalk and boards, overhead or liquid crystal display (LCD) projectors, textbooks, tools, real-world objects, etc. The learning tool or resource which was primarily used in Indonesia was the blackboard. As many as 97% of the classrooms used blackboards, and in other countries the percentage was

Figure 4.32 **Use of various resources (proportion of videotaped classes where the given resource was used)**



Source: Indonesia results combined with data from table 5.6 in Hiebert, J. et. al., (2003), page 114
Note: OCs is an abbreviation for "other countries" and the lower number represents the country with the lowest proportion of the videotaped classes in which the resource was used, while the upper boundary represents the country with the highest proportion.

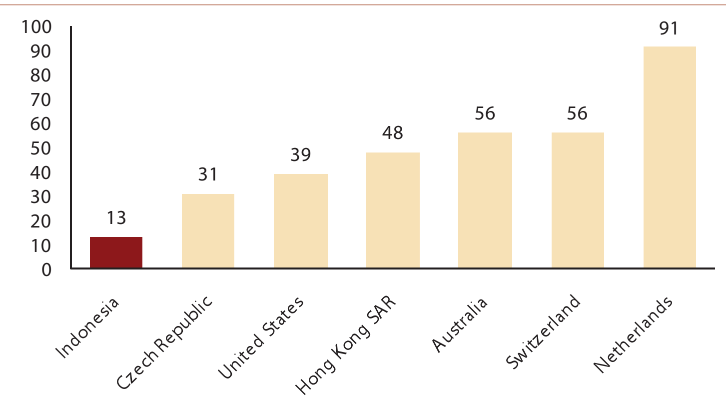
between 71% and 100%. In addition, in Indonesia 9% of the classrooms used projectors while in other countries projector use was between 3% and 59%. Similarly, 93% of the schools used textbooks as a teaching and learning resource, and 85% used special mathematics tools such as protractors, compasses, and graph papers, compared to a usage of between 30% and 86% in other countries (Figure 4.32).

Use of real objects was relatively more prevelant in Indonesia than in other countries. Approximately 28% of the lessons in the sample used real objects compared to 4% to 21% in other countries.

b. The use of calculators

The percentage of lessons in Indonesia that used a calculator was very small -- only 13% schools in the sample (Figure 4.33). This was in great contrast to the practice in other countries, where the usage could be up to 91%. This situation in Indonesia was due to the schools' or teachers' policy of not permitting calculator use in the mathematics learning process, the intention being to familiarize students with the national mathematics examination during which students are not allowed to use calculators.

Figure 4.33 **Percentage of lessons which used calculators**



Source: Indonesia results combined with data from table 5.6 in Hiebert, J. et. al., (2003), page 115
Note: Japan is not included because too few cases were reported.

Section 5

Classroom Patterns: Indonesia's "Lesson Signature"

The video study data allows for analysis of what takes place in the classroom over time. The videos are coded in a way where segments are created to identify what happens every second in each classroom. While this is useful for examination of the individual classroom, it also allows for combining across classrooms to identify common patterns of the particular lesson features analyzed in the previous section. Such patterns were labeled by *Hiebert et. al* (2003) to be a country's "lesson signature".

The analysis in the following section merges all classroom data and then looks for patterns. The lesson signature is constructed by looking at the activities and teaching practices taking place in the 72 classrooms across the different layers for each percentage of lesson time elapsed.

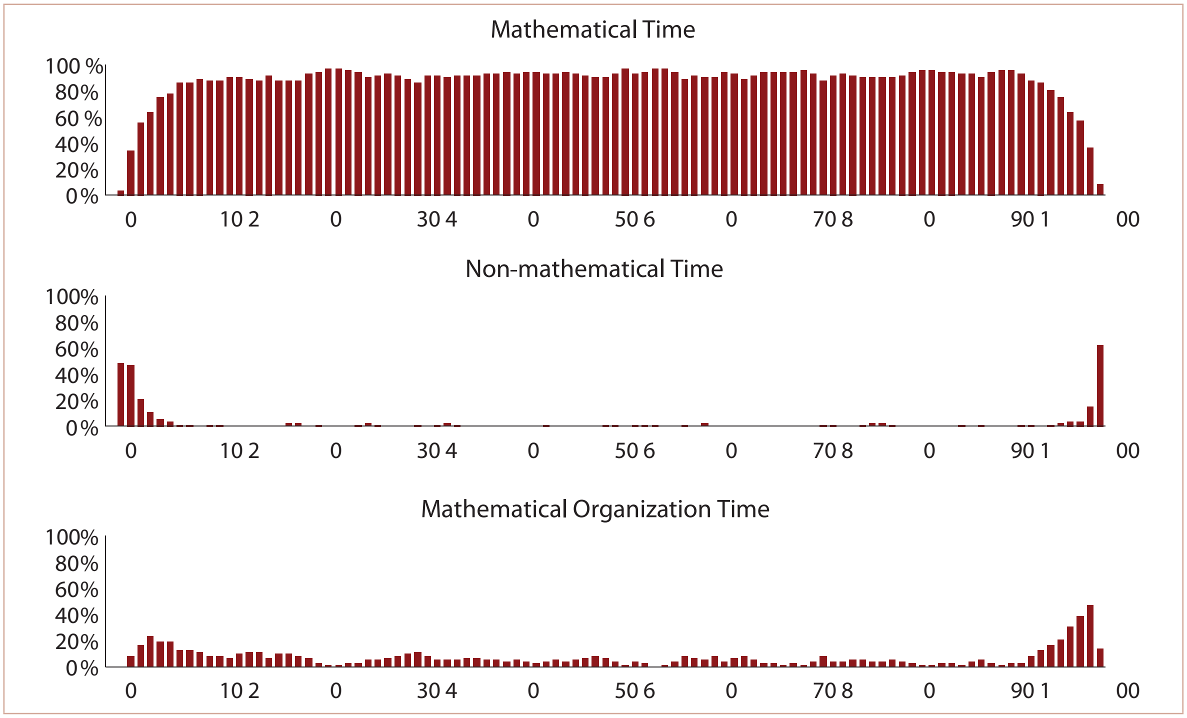
5.1. Method of Constructing the Lesson Signature

The classes were analyzed based on percent of time that passed rather than absolute time. The length of each class varies, with the videos in Indonesia's sample having a range of 40 to 100 minutes. In order to combine the data from each class, the actual time was not used but rather the relative time from 0 to 100% of class time. For example, for the class of 40 minutes, the 50% mark (halfway through the class) was 20 minutes, while for the class of 100 minutes the mark was 50 minutes. For each class the study team determined what activity was taking place as each percentage of the total class time passed (1%, 2%, 3%, etc.).

5.2. Pattern of Mathematical, Non-mathematical and Mathematical Organization Time

Non-mathematical time and mathematical organization time tended to take place at the beginning and end of the lesson. Indonesia stood out in contrast to the other countries in that a relatively significant amount of time was spent on non-mathematical and mathematical organization time, with 89% dedicated to mathematical activities compared to 95% to 98% in other countries. As can be seen in Figure 5.1 below, the non-mathematical time took place almost exclusively in the first 5% and last 5% of class time. This often involved an introductory prayer or opening ceremony or a closing activity. The fact that Indonesia dedicated more time to non-mathematical activities might indicate that class time is seen as not only a time for learning but also a time for cultural rituals. The fact that so much time was dedicated to these activities might be due to the fact that Indonesia's lessons were significantly longer than in other countries (70 minutes vs. between 41 and 51 minutes) and involved more transitions between activities (e.g., from lecture to group work), requiring that the teacher spend more time on mathematical organization activities.

Figure 5.1 Lesson Signature of layer 1: Mathematical, non-mathematical and mathematical organization time



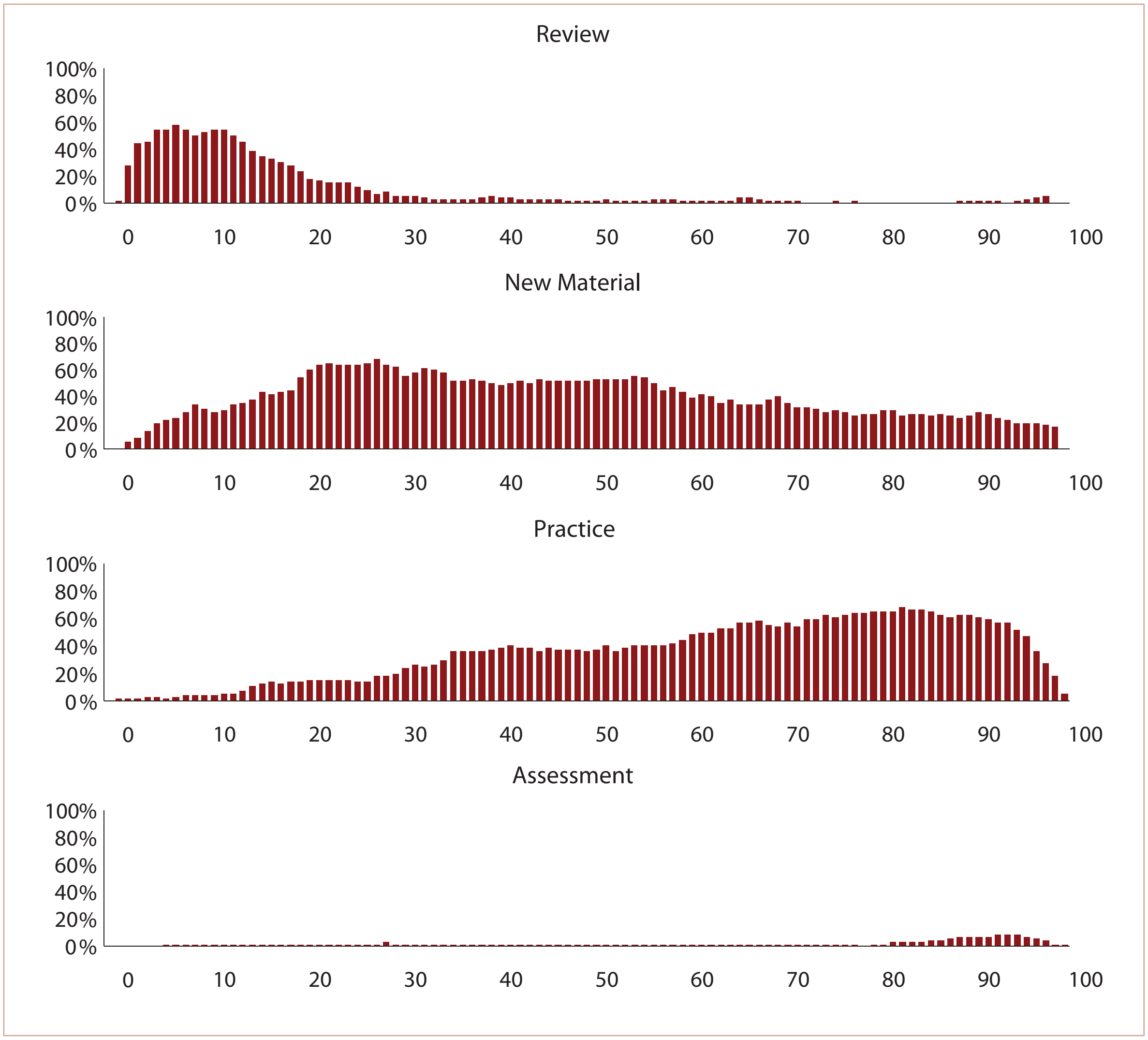
Note: the three layers are mutually exclusive and add up to the full class time.
Graphs show what percent of the 72 classes are conducting the given activity for each percentage of lesson time elapsed

5.3. Pattern of Purpose of the Lesson Segment

In the time dedicated to review and the presentation of new content and practice, Indonesia stood out in contrast to other countries in that less time was dedicated to review and more time was dedicated to practice. Figure 5.2 below shows that review in Indonesia took place in the beginning of class; by the time that 25% of the class time had passed, almost all review had been completed. In the lesson signatures of other countries (shown in Figure 5.3), by the time 20% of the class had passed, most classrooms had also stopped review (with the exception of the Czech Republic and the United States which had over 50% of classroom time dedicated to review). Indonesia's difference is in both the percentage of classes that undertake review and the length of the review. Examination of the data indicates that 14% of all classes had no review take place, 24% spent less than one minute and 34% spent less than 5 minutes on review.

The general pattern of first conducting review, followed by introducing new content, followed by practice was the same as in other countries although Indonesia tends to begin practice earlier in the lesson. The lesson signature indicates that as early as within 40% of lesson time many classes were conducting practice activities and that by the second half of class time, most classes were conducting practice activities. In contrast, Figure 5.3 shows that most other countries did not tend to begin practice activities until after 60%-70% of the class time had passed.

Figure 5.2 **Lesson Signature of the purpose of segments: Review, new content, practice and assessment**



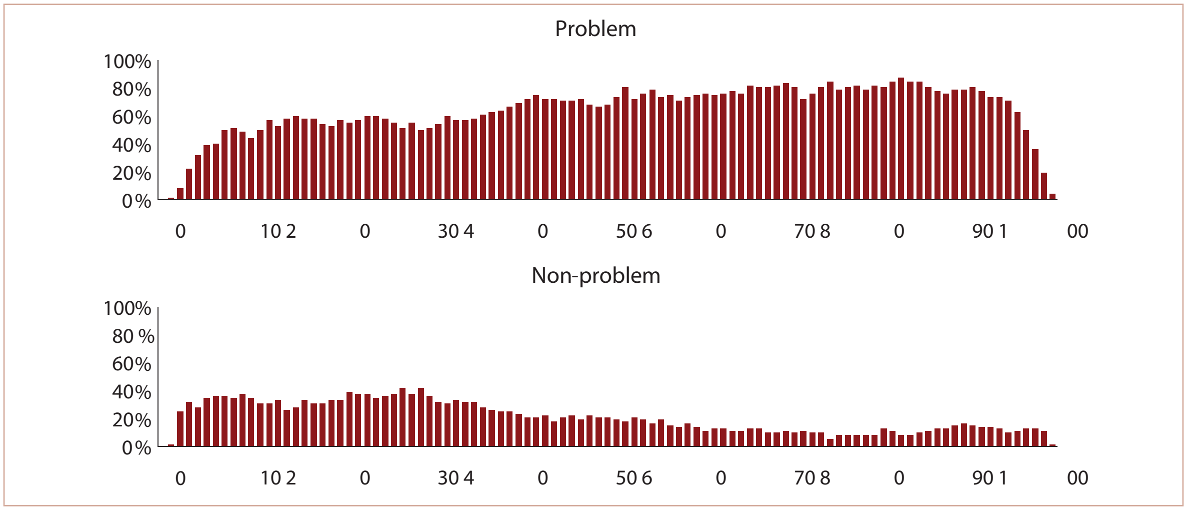
Note: Review, New content, practice and assessment are mutually exclusive and add up to the full "mathematics time" as specified in Layer 1. The non-mathematical and mathematical organization times does not contain these activities.
Graphs show what percent of the 72 classes are conducting the given activity for each percentage of lesson time elapsed

Figure 5.3 **Lesson Signature of the purpose of segments for other countries**

5.4. Problem vs. Non-problem

Non-problem work tended to take place earlier in the class, whereas problem work, while consistently visible throughout the lesson, tended to be slightly higher in the second half of the lesson. As discussed in Section 4, Indonesia spent relatively more time on non-problem segments than other countries. Much of this activity involved, for example, mathematical information such as presenting or discussing new material or material previously presented, perhaps through a brief lecture by the teacher. It also involved contextual information such as describing the goal for the lesson and presenting historical background. Such activities were more likely to take place at the beginning of the lesson.

Figure 5.4 Lesson Signature of problem vs. non-problem mathematics time

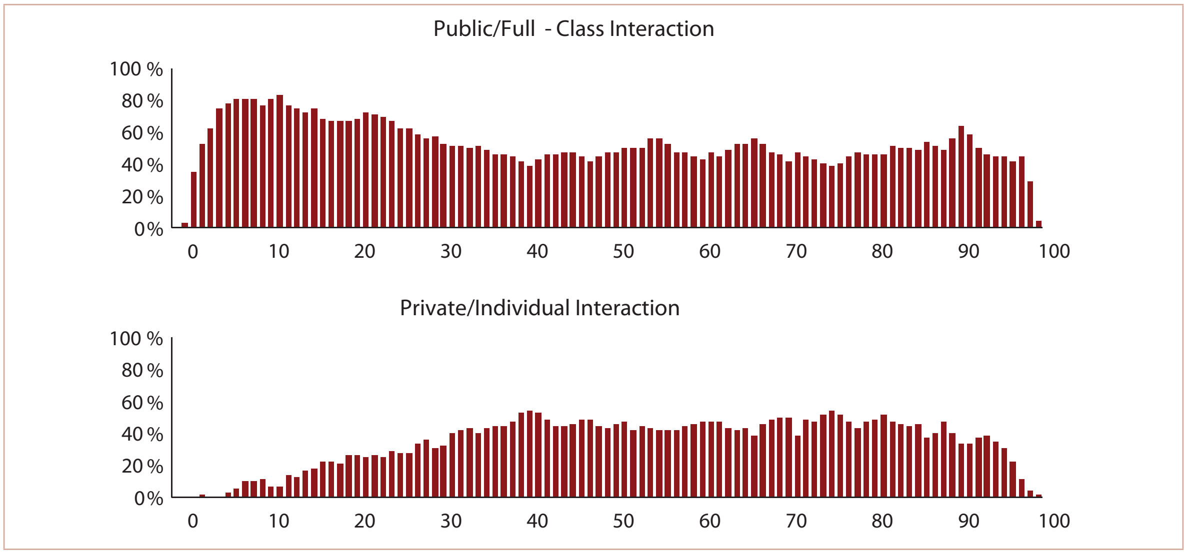


Note: Problem and non-problem time are mutually exclusive and add up to the full "mathematics time" as specified in Layer 1. The non-mathematical and mathematical organization times does not contain these activities.
Graphs show what percent of the 72 classes are conducting the given activity for each percentage of lesson time elapsed

5.5. Public vs. Private Interaction

As noted in the previous section, the time between public and private interaction was 57% to 43% respectively. As can be seen in Figure 5.5 below, the beginning of class tended to involve public interaction, but by the 40% mark, the two were evenly divided. A slight bulge in public interaction occurred near the end of class, often with groups re-gathering to discuss what had been practiced that day and performing tasks such as assigning homework.

Figure 5.5 Lesson Signature: Public (full class) vs. private (small group and individual) interaction

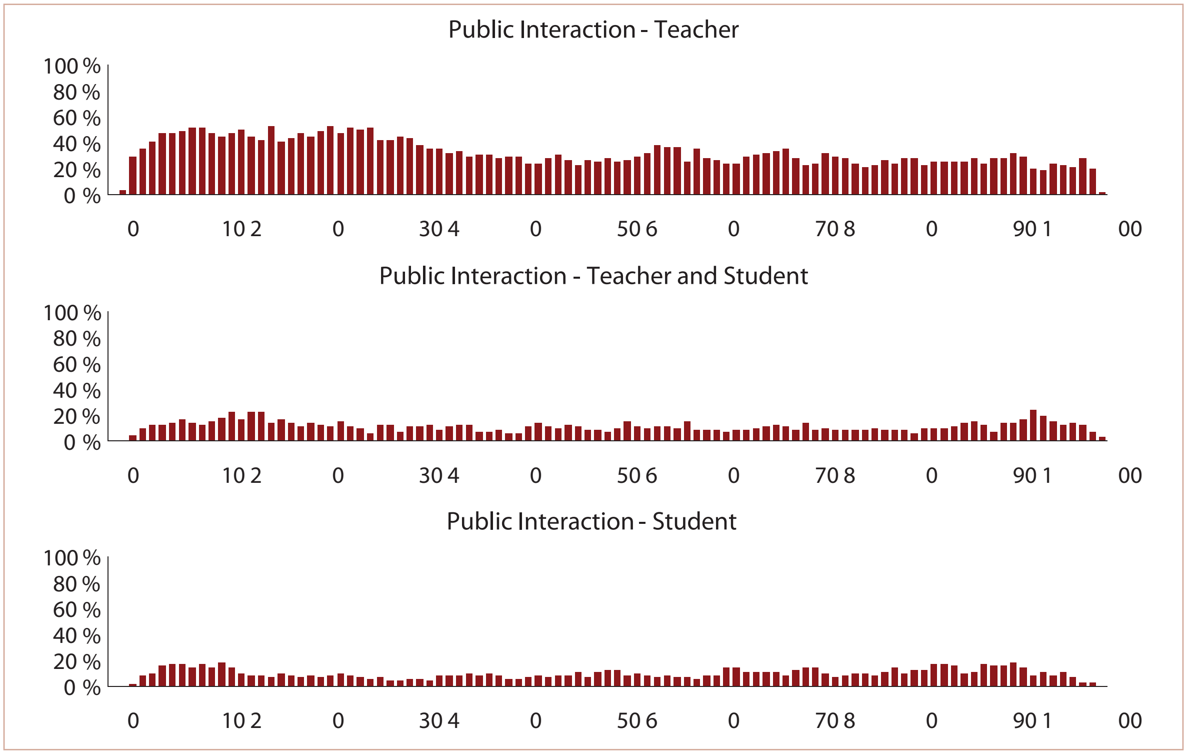


Note: Public/full class interaction and Private/Individual interaction time are mutually exclusive and add up to the full "mathematics time" as specified in Layer 1. The non-mathematical and mathematical organization times do not contain these activities.
Graphs show what percent of the 72 classes were conducting the given activity for each percentage of lesson time elapsed

5.5.1. Public Interaction Breakdown (Teacher, Teacher and Student, Student)

Public interaction showed slight patterns, but all forms were fairly evenly distributed. The different types of public interaction are shown in Figure 5.6 below. The method of teacher lecturing was by far the most common form of public interaction, with teacher and student interaction (e.g., a question and answer segment) and student interaction (e.g., student presenting) being much less common. The teacher lecture had a slightly larger bulge at the beginning of class. Student and teacher interaction tended to happen slightly more at the beginning and end of the class. This was often due to students discussing their homework results or presenting the results of their practice assignment.

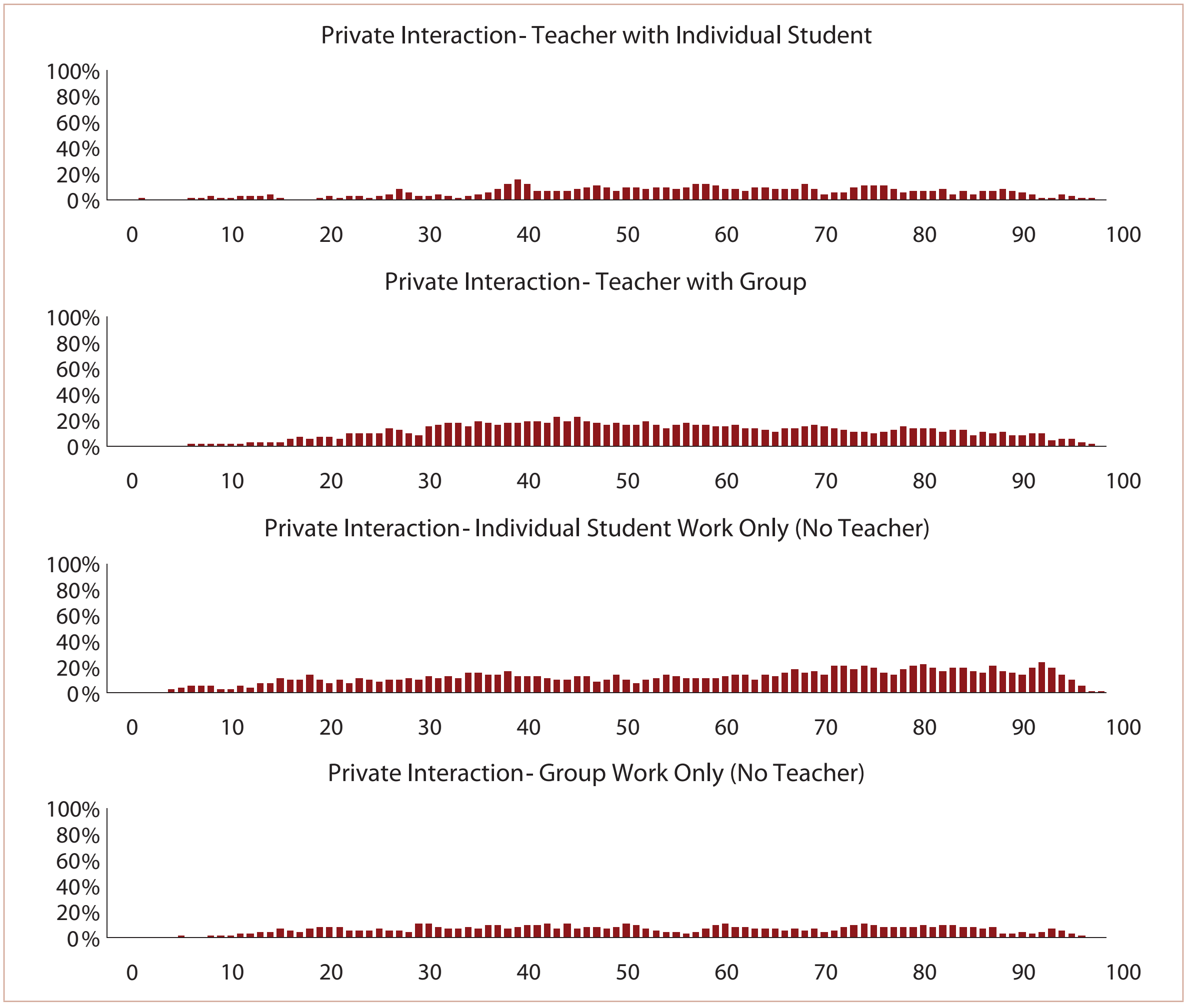
Figure 5.6 Lesson Signature of public interaction breakdown



5.5.2. Private Interaction Breakdown

The pattern for private interaction was, again, surprisingly evenly disbursed across the lesson. Individual student work that did not involve the teacher tended to be a bit more common in the latter half of the class, while teacher-student group interaction was slightly more common in the middle portion of the class. Group work in general (combining group work with teacher interaction and group work without teacher interaction) tended to take place earlier in the class than individual work (either with or without teacher interaction.)

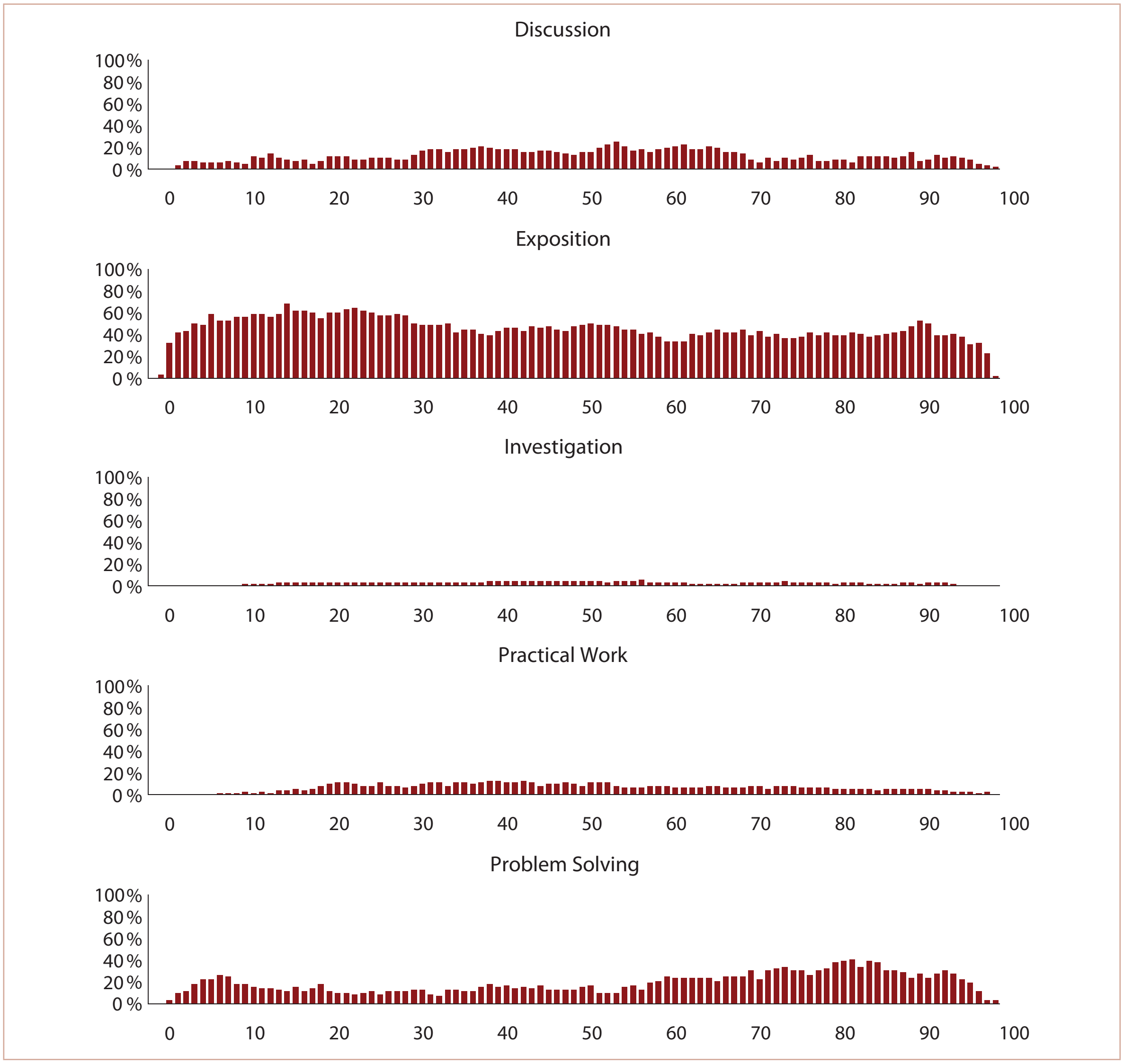
Figure 5.7 Lesson Signature of private interaction breakdown



5.6. Teaching Strategy

Exposition tended to take place more often earlier in the class while problem-solving tended to take place later in the class. As noted in *4.4.1 Teaching Strategies*, exposition was the most common form of teaching strategy, making up 52% of the time. Figure 5.8 indicates that exposition had a bulge in the earlier portion of the class while problem-solving tended to take place more often in the latter portion of the class. Discussion was fairly evenly spread but tended to happen most often in the middle of the class.

Figure 5.8 **Lesson Signature of discussion, exposition, investigation, practical work and problem-solving**



5.7. Description of the Typical Pattern by the Study Team

Before going into the actual data patterns, it would be useful to look at insights from the study team on what a typical lesson signature of a class was and what interesting activities were seen in the videos. Because of their expertise as mathematics teachers and teacher trainers, their descriptions capture how teachers are actually trained and contain subtleties that cannot be captured through simple coding. Three distinct sections were described: (i) the introduction stage, (ii) the development stage, and (iii) the closing stage.

Introduction Stage: The lesson begins with checking the readiness of students for the class and may include homework discussion. For example, questions related to the homework assignment include how many problems they completed, whether there were problems that the students considered difficult and which problems need to be further discussed. The ways in which teachers discuss homework vary. Some teachers only ask for the answer of each problem orally while others ask students the answers of problems that they considered did not need further discussion with the remaining problems being described by teachers on the blackboard. There are some schools that use almost all the lesson time for doing and/or discussing the homework problems so there is no time to discuss new material. This is because only some students or no students actually completed the homework.

Development stage: This stage contains the introduction of new content and usually begins by building the motivation of students with an explanation of the importance of studying the lesson, followed by the teacher posing questions of prerequisite knowledge that will be used in the development of the new material. At this stage, teachers usually discuss the facts and concepts of the new lesson. Understanding concepts and facts is usually done by providing practice, with preliminary discussion of some examples. For teachers who are more aware of the need for proper time management, the problems that have been solved by the students are discussed as a full class. The students can identify what parts of the new lesson were not well understood so they can be discussed again. But there are some teachers who provide practice without good planning, so many unresolved problems are given as homework.

Closing stage: In this section, some of the teachers, often with students, build summaries of the new lesson and give students tasks to work on as homework problems. Many teachers do not make a summary but instead directly give the homework assignment.

Section 6

Regression Analysis to Identify Relationships between Teaching Practices and Student Mathematics Scores

Regression analysis is employed to determine what relationships exist between teaching practices and student mathematics scores. The coding and analysis presented in Section 4 provides detailed, quantifiable insights into what happens in Indonesia's classrooms. Using the same methodology as seven other countries that conducted video studies provided a reference point for where Indonesia falls relative to these countries. But what do these numbers mean in terms of student achievement? The fact that Indonesian teachers spend comparatively less time in review (for example) does not necessarily mean that Indonesia should pursue a policy of encouraging teachers to spend more time on review. The fact that Indonesian teachers and students speak significantly less than in other countries does not necessarily mean that more verbal interaction is necessary. By using the TIMSS sample for the video study, a unique opportunity is provided to identify relationships between student achievement (examination scores) and teaching techniques.

This section first lays out the methodology used in identifying relationships between student achievement and teaching technique, followed by the results obtained. Many teaching practices emerged as having a statistically significant relationship with student mathematics scores.

It must be recognized upfront, however, that the data only provides a snapshot with a single examination score so it is not possible to create a "before and after" picture of student achievement. It is therefore also not possible to determine the cause and effect relationship between teaching practices and student achievement. Still, the snapshot provide insights into how teaching practices relate to student achievement and, combined with theory and existing knowledge of what would be expected to lead to student achievement, a picture of what works in Indonesia can be at least partially formed.

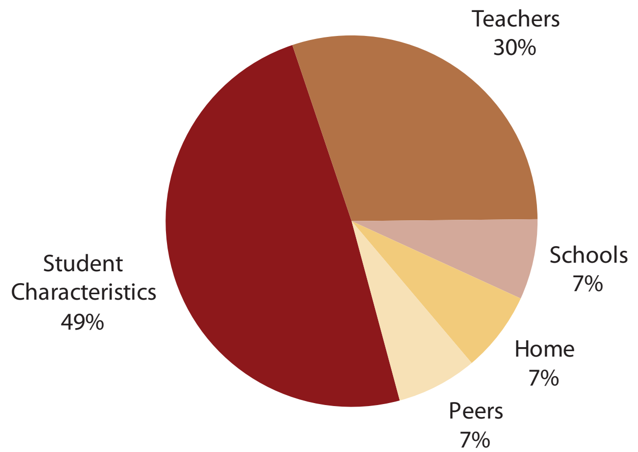
6.1. Methodology of Regression Analysis

A key challenge in education is to determine what can be done to improve student outcomes. In general, countries develop their education policy based on what is believed will lead to students learning what they want to and need to learn both in terms of specific knowledge and more general skills, values, and attitudes. [18] For example, Indonesia has been promoting a more student-centered learning approach[19] with the idea that it is more effective for student learning, but is it true that the teacher-centered "chalk and talk" approach to teaching is less effective than a more interactive, student-centered approach? While the data from the video study certainly cannot provide a definitive answer to such a question, it does at least permit insights into which classroom instruction and teaching practices have positive or negative relationships with student learning.

Regressions reveal the relationship between various teaching practices and student mathematics scores while controlling for many other factors that are known to have an influence on student achievement. In its simplest form, the classroom instruction and teaching practices captured through the coding of each video can be linked to TIMSS examination results through two-variable correlations, but such results are misleading because they do not capture the complexity of student learning or the multiple factors influencing student achievement. In order to gain a more accurate picture of how teaching practices are related to student achievement, a model must be constructed to separate out (control for) these multiple factors and to isolate teaching practices. The following section defines the model constructed for the regression analysis.

6.1.1. Steps in Framework Development

Figure 6.1 Estimated influence of key factors on student achievement



Source: Professor John Hattie from the University of Auckland

Step 1: Recognizing the multiple influences on student achievement

A critical first step in developing a methodology was to recognize the complexity of, and multiple influences on, student achievement. While teachers certainly play an important role in how much students learn, they are only a piece in the overall puzzle. Professor John Hattie from the University of Auckland performed a meta-analysis of various studies that attempted to quantify influences on student achievement. While placement of a percentage of influence on student achievement should be viewed with extreme caution, Hattie's meta-analysis of of 51 studies at least provides a basis for developing a model. The results indicate that the biggest influence on student

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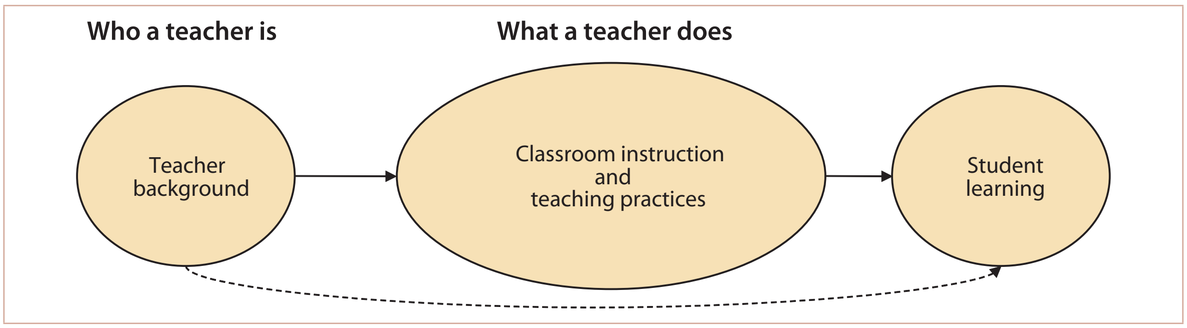
19 The term "student-centered learning" has different interpretations, but in the case of Indonesia it is similar to what Rogers (1985) describes as the shift in power from the expert teacher to the student learner, driven by a need for a change in the traditional environment where in this 'so-called educational atmosphere, students become passive, apathetic and bored' (Rogers, 1986, page 25). The teacher-focused/transmission of information formats, such as lecturing, have begun to be increasingly criticized, and this has paved the way for the widespread growth of 'student-centered learning' as an alternative approach.

achievement is student characteristics (socio-economic status, inherent intelligence, etc.) which account for approximately half of student achievement outcomes. Teachers are the next biggest influence, accounting for approximately 30%. School, home and peer factors account for approximately 7% each. For the purposes of developing the framework, student, school, home and peer characteristics should therefore be taken into account and controlled for when linking student achievement and teaching techniques.

Step 2: Separating teacher background vs. classroom instruction and teaching practices

The next step in developing the framework was to separate out *who a teacher is* from *what a teacher does*. A teacher's background includes characteristics such as educational attainment, years of experience, whether the teacher has majored in mathematics and the teacher's level of motivation. What a teacher does in the class includes how the teacher structures the lesson, what the teacher does to prepare the lesson plan, the content of the lesson and the choice of teaching techniques. Figure 6.2 below shows the separation between teacher background and classroom instruction and teaching practices. The dotted line from teacher background to student learning is intended to capture the fact that a teacher's background (competency, motivation, etc.) directly influences student learning, but that much of the teacher's influence is captured through his/her classroom instruction and teaching practices.

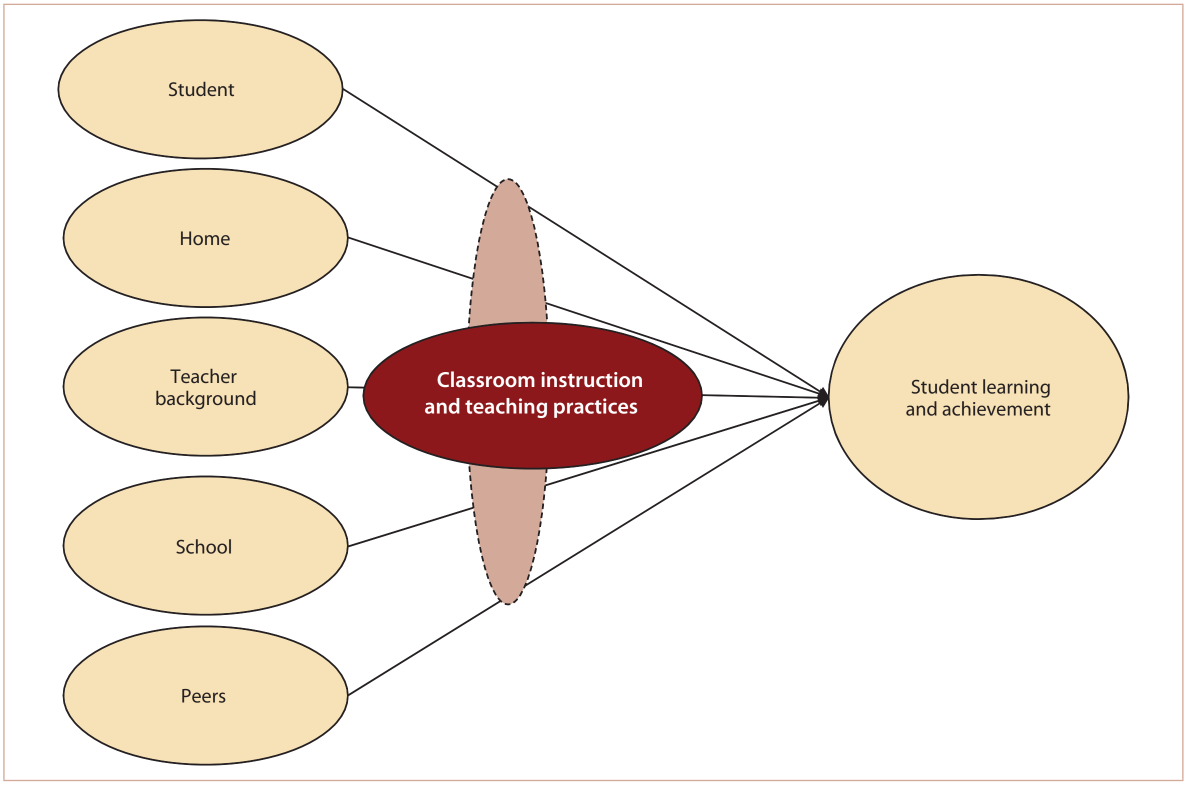
Figure 6.2 Illustration of teacher background vs. classroom instruction and teaching practices



Step 3: Establishing a framework for analysis

By combining the two above steps, a model was then constructed to show the multiple factors influencing student achievement. For the purposes of this study, classroom instruction and teaching practices are the main area of interest. While student, school, home and peer characteristics are certainly of importance, they are included here as control factors rather than as the main factors of interest. Teacher background is also of interest but mainly in relation to how it relates to classroom instruction and teaching practices. Figure 6.3 below depicts how classroom instruction and teaching practices are the central focus of the model. While the model is most directly related to teacher background, it is also influenced by the other factors influencing student learning. For example, for a large class the teacher may tend to have students work frequently in small groups, whereas for a small class more public (full class) interaction may be used more often. The teacher's background is considered the factor most related to choice of classroom instruction and teaching practices and therefore has the closest link.

Figure 6.3 **Framework used in analyzing classroom instruction and teaching practices**



6.1.2. Use of Multiple Data Sources

The above framework requires data for the various dimensions of student, home, school, peer and teacher background, along with classroom instruction and teaching practices. The TIMSS results (as described above in 3.2.3.2), along with additional data collected for the study, provide a rich array of data that can be used in the analysis. Video study data was also used, including:

- Video coding: breakdown by second of all classroom activities
- Observation instrument to complement the video
- Teacher questionnaire
- Student questionnaire
- Review and ranking of teacher's lesson plan (score 1-40)
- Homework evaluation

6.1.3. Recognizing the Limitations

While there is value in attempting to identify linkages between student achievement and teaching techniques, the challenges in attempting such analysis are vast. These challenges must be kept in mind both for developing the models and in interpreting the results. A few of the key challenges to keep in mind for the analysis include:

- **The multiple factors that affect student learning outcome are extremely complex and cannot easily be captured through surveys.** Many unobservable factors exist, and indicators that attempt to measure factors such as student and teacher motivation are relative to the learning environment.

- **Because of data limitations, the given model may contain confounding variables, making conclusions on the cause and effect of teaching techniques on student outcomes potentially inaccurate.** If an extraneous variable in the statistical models presented below correlates (positively or negatively) with both the dependent variable and the independent variable, then a *type 1 error* exists. It is possible that an erroneous 'false positive' conclusion could be made in linking teaching techniques with student outcomes. It is therefore important to only view the results in terms of relationships and not cause and effect.
- **Teacher factors cannot easily be isolated from other factors.** Good schools are likely to attract better teachers. The school environment is likely to influence teacher motivation, with positive environments most likely providing greater teacher motivation. Such factors create issues of multi-collinearity in models.
- **Teachers will choose techniques based on their personal strengths.** For example, a teacher who has a stronger mathematics background may choose to present problems using mathematics language and symbols more often than real-life scenarios.
- **A teacher's technique will be, in part, chosen to address specific student needs.** For example, the same teacher may choose different teaching techniques in a high ability classroom vs. low ability classroom or large vs. small class size.
- **Two teachers using the exact same technique may have different outcomes based on their abilities.** For every teaching technique, the study team found examples of what they thought were good and bad uses of the technique. A teaching technique used in a given classroom may have a negative relationship with student mathematics scores, but it may be that a teacher who is properly using the technique can have positive results.

6.1.4. Model Development

Identification and Grouping of Teaching Techniques and Classroom Instruction Variables

The main focus of the regression analysis is to identify the relationship between student mathematics scores and the various teaching techniques and classroom instruction approaches used. The coding of the videos was done following the methodology developed by Hiebert et al (2003). It is the results of this coding that are to be analyzed in terms of student mathematics scores on the TIMSS examination, using the rich set of survey data in order to control for various factors. The main grouping and coding are presented in Table 6.1 below:

Table 6.1 Grouping of teaching techniques and classroom practices

Grouping	Variables
Structure of Time	Mathematical time Non-mathematical time Mathematical organization
Activity Purpose	Review New content Practice Assessment
Teaching Strategy	Discussion Exposition Investigation Problem-solving Practical work
Interaction Type	Public (full class) Private (small group or individual)

Grouping	Variables
Public time	*Teacher only* *Teacher and student* *Student only*
Private time	*Individual only* *Individual with teacher* *Group only* *Group with teacher*
Problem vs. non-problem	Problem Non-problem
Routine vs. non-routine	Routine problem-solving Non-routine problem-solving
Use of materials	Use projector Use textbook Use mathematics materials Use calculator Use real-world objects

The percentage of time spent on various teaching techniques was determined to be the most appropriate measure. The above variables were analyzed based on the amount of time in two forms: (1) absolute terms and (2) as a percent of total time for the given category. This distinction is important because classes are of different lengths and teachers use different techniques, so analyzing certain categories would be misleading if only viewed in absolute terms. Analyzing in terms of percentages is considered to be the more accurate measure. The time spent is calculated as the portion of time for a given grouping. In most cases it is a percent of total mathematical time, but in some cases it is the percent of a different grouping. For example, the sub-groupings of public time (teacher only, teacher and student, student only) are a percent of total public time rather than total mathematical time.

Initial Identification of Predictor (Control) Variables through Stepwise Regression

Over 1,000 student, teacher, school, community and home variables were available from the various surveys, but these had to be narrowed down to the key variables influencing student achievement. A method was necessary to choose the variables to include in the models. An approach of logic and initial analysis was used to identify the best candidate variables. The models should certainly be based on what is already known about influences on student achievement. The use of educational theory and the results of previous studies were used as for initial selection. For example, the education level of parents has been shown in many studies to have an influence on student achievement. It was therefore important to use variables that capture this dimension.

But it is possible that good variables that have been captured and, in fact, influence student achievement could be left out. In order to not allow these variables to slip through the cracks, an initial correlation analysis was performed between student mathematics scores and all survey variables. Variables that had high correlation were brought to the next stage of analysis.

Model Structures

General model structures were then developed in order to look at the influence of the various teaching techniques on student learning. Two waves of models were developed, with the first wave being kept to a minimum number of variables and the second wave including additional variables also seen to be of interest and statistical significance. The third version within each wave includes dummy variables for 16 of the 17 provinces included in the sample.[20] Models both with and without province variables were run because while the importance of regional differences is recognized, the dummy variables for half of the provinces tended to be dropped in the regression. While the results are still valid, it was decided that both with-province and without-province models would be of value.

Table 6.2 Models used for regressions

Wave 1	Small set of key variables	Logic behind model
- Model 1.1:	Inclusion of a small set of key home, student, school and classroom variables but not including teacher background variables	To get a picture of the relationship of teaching techniques with student mathematics scores regardless of teacher background
- Model 1.2:	Same variables as in model 1.1 but also including a small set of teacher background variables	To see how the results change when teacher background is introduced
- Model 1.3:	Same variables as in model 1.2 but including provincial variables	To control for regional factors*
Wave 2	**Similar to Wave 1 but with a larger set of variables**	
- Model 2.1:	Inclusion of a larger set of key home, student, school and classroom variables but not including teacher background variables	Same as model 1.1 but introducing additional variables found to be statistically significant
- Model 2.2:	Same variables as in model 2.1 but including teacher background variables	Bringing in a larger set of teacher variables
- Model 2.3:	Same variables as in model 2.2 but including provincial variables	To control for regional factors*

For each of the above models the following general formula was used:

(1) $$Math_i = Technique_{ij} + Home_i\beta_h + Pupil_i\beta_p + Community_k\beta_{cm} + School_k\beta_s + Class_n\beta_c + Teacher_n\beta_t + u_i,$$

- ***Math*** denotes the mathematics score of a given student *i*
- ***Technique*** denotes the specific teaching technique being analyzed from the list *j* of all teaching techniques (It is important to note that only one teaching technique is analyzed at a time.)
- ***Home*** denotes a vector of observed home characteristics of pupil *i*
- ***Pupil*** denotes a vector of observed characteristics of pupil *i*
- ***Community*** *denotes a vector of observed characteristics where school k is located*
- ***School*** denotes a vector of observed characteristics of school *k*
- ***Class*** denotes a vector of observed characteristics of classroom *n*
- ***Teacher*** denotes a vector of observed characteristics of teacher *n*

The teaching technique variables were inserted into the models one at a time. For example, the percent of time spent on introducing new content was put into Technique and the regression was run to obtain results. The variable was then replaced by a new one (e.g., percent of time spent on practicing), and the regression was run again. A total of 250 teaching techniques was analyzed for each of the 6 models, so a total of 1,500 regressions were run.

In a given classroom there are many students who are all being exposed to the same school, class and teacher background characteristics. This creates a type of correlation (between observations) which is called an intra-

20 One province was left out in order to be the baseline of comparison with the other provinces.

class correlation. If this is not taken into account, the standard errors of the estimates will be off, rendering significance tests invalid. In order to address this issue, the records were clustered at the classroom level.

6.2. Regression Results

The t-statistic was used as the outcome of interest because it captures both the direction and the statistical significance of the variables on mathematics scores. The full results of the regressions can be found in *Appendix 5: Regression Results,* but because a total of 1,500 regressions was run, a consolidated presentation is given here. For the purposes of this section, the focus is on:

a) Determining whether each variable's relationship is positively or negatively related with mathematics scores, and
b) Determining whether the relationship is statistically significant.

An admittedly important dimension that is not shown in the following summary tables is the coefficient, which represents the estimated rate of change of one variable (y) as a function of changes in the other. For space constraints, however, this value is not presented in this section and can instead be seen in the appendix.

The t-statistics were labeled based on their level of statistical significance. Although the results will vary depending on the regression, in general, a t-statistic of over 1.67 is statistically significant at the 10% level (90% confidence interval); above 2.00, statistically significant at the 5% level (95% confidence interval); and above 2.58, statistically significant at the 1% level (99% confidence interval). T-statistics of -1.67, -2.00 and -2.58 are also significant at the 10%, 5% and 1% levels, but indicate a negative relationship.

Table 6.3 Legend for presentation of statistical significance and direction of variables in the regression

2.60	POSITIVE relationship with mathematics scores and statistically significant at 1% level (99% confidence level)
2.01	POSITIVE relationship with mathematics scores and statistically significant at 5% level (95% confidence level)
1.68	POSITIVE relationship with mathematics scores and statistically significant at 10% level (90% confidence level)
-1.68	NEGATIVE relationship with mathematics scores and statistically significant at 10% level (90% confidence level)
-2.01	NEGATIVE relationship with mathematics scores and statistically significant at 5% level (95% confidence level)
-2.60	NEGATIVE relationship with mathematics scores and statistically significant at 1% level (99% confidence level)
	Variable is not included in the regression

6.2.1. Identification of Control Variables

Through the process of stepwise regression analysis, a total of 27 key home, student, school, classroom and teacher background variables were identified for inclusion in the various models. In regression 1.1, a total of 10 variables were included; six additional teacher background variables were included in model 1.2 for a total of 16; and the same 16 plus additional provincial variables [21]are included in Model 1.3. Models 2.1 – 2.2 follow the same pattern, starting with 20 variables in model 2.1, then adding seven teacher background variables in 2.2 and finally adding the provincial variables in 2.3. The results of the t-statistics, with color coding for statistical significance, are presented below:

21 The province variables are coded as dummy variables, with 11 dummy variables included and South Sulawesi left out of the regression so that it represents the baseline province.

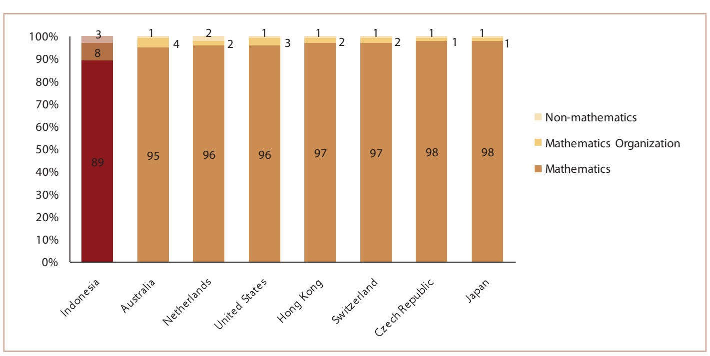
Table 6.4 **T-statistic results for home, student, school, class, community and teacher background variables (with mathematics examination score as the independent variable)**

		Wave 1			Wave 2		
	Covariance	**R 1.1**	**R 1.2**	**R 1.3**	**R 2.1**	**R 2.2**	**R 2.3**
HOME							
Parents' education	4.53	3.87	3.65	4.28	4.19	4.18	4.93
Dictionary available	5.26	4.62	4.37	3.91	4.36	4.27	3.85
Computer available	2.70				0.59	0.69	0.56
STUDENT							
Student age	**-6.59**	**-6.19**	**-6.20**	**-5.90**	**-5.81**	**-5.75**	**-5.46**
Hours working at outside job per week	**-5.68**	**-5.44**	**-5.44**	**-5.20**	**-4.60**	**-4.36**	**-4.16**
Total homework time per night	4.62	4.46	4.71	4.37	4.74	4.99	4.74
Hours spent playing sports per week	-1.25				-2.19	**-2.71**	**-2.90**
Time spent reading books	0.89				1.59	1.61	1.56
COMMUNITY							
Community poverty rate	**-3.35**	-2.09	-1.70	-1.67	-2.02	-1.67	-1.94
Community size	0.01				0.81	0.71	1.67
SCHOOL							
Private	**-2.71**	-2.50	-1.75	-2.48	-2.28	-1.27	-1.31
Religious	**-3.52**	-2.36	-2.28	-2.30	-2.49	-2.51	-2.52
Rural	-1.09	0.90	1.23	-0.40	1.18	1.33	-0.48
Index of school resources	1.58	-0.66	-0.87	-0.97	-0.57	-0.73	-0.51
Attendance rate	0.27				-0.25	-0.18	-0.07
Index of school condition	0.09				-0.54	-0.63	-1.01
Student perception of student effort	**-6.34**				**-5.62**	**-5.41**	**-5.07**
CLASS							
Class hours of mathematics per week	-0.38	0.04	0.64	-0.34	0.16	0.48	-0.88
Class size	1.89	1.59	2.09	0.97	1.29	1.56	0.43
Adequacy of facilities	1.48				0.70	-0.12	0.24
TEACHER BACKGROUND							
Years experience	4.27		1.73	0.71		1.55	0.24
Majored in mathematics	0.57		-1.58	-1.33		-1.25	-0.71
Female	1.39		2.02	2.26		2.38	2.66
Teacher is a civil servant	2.30		0.20	-0.36		0.68	0.51
Training in classroom management	-0.61		-1.28	-0.83		-1.45	-0.75
Developed mathematics pedagogy	1.19		0.95	0.75		-0.23	-0.71
Level of job satisfaction	0.35					0.91	0.85
Province dummy variables included		**N**	**N**	**Y**	**N**	**N**	**Y**

The focus of this study is <u>not</u> to attempt to measure all characteristics leading to student achievement, but the results of the control variables are still of interest. The above variables are intended to serve as controls in measuring the relationships between teaching techniques and student mathematics scores. Still, some brief points can be made about the results:

- ***HOME:*** The home variables of parents' education and dictionary showed a strong positive relationship with test scores, meaning the higher the education level of the parents, the higher the student's test score was. Having a dictionary in the house also had a strong positive relationship. While the dictionary wouldn't directly be used in math, it may be an indication of the importance of education in the household and, in some cases, an indication of the family's wealth.
- ***STUDENT:*** Many student characteristics had a strong statistically significant relationship with mathematics scores. Age had a negative relationship, meaning older students tended to score lower. Because all students were in 8th grade, the older age tends to indicate that the student had to repeat previous grades or started school late. Students who work also scored lower. An 8th grade student who is working tends to come from a poorer family, so this result is likely catching socio-economic factors. Student time spent on homework had a strong positive relationship, likely capturing student effort and motivation.
- ***COMMUNITY:*** A community's poverty rate generally had a negative and statistically significant relationship with mathematics scores, although it was not as strong as what might be expected with confidence intervals of only 90% for some of the regressions. Community size, on the other hand, tended to have a positive relationship with mathematics scores, but it was only statistically significant in the final regression.
- ***SCHOOL:*** Private and religious schools had a negative relationship with test scores, although in the final two models the private variable was not statistically significant. Perception of student effort of their peers at school was also negatively correlated and is statistically significant at the 99% confidence interval. This is counterintuitive in that we would expect schools with students trying harder to score higher. It may be that the concept of "students try" is relative, and in higher achieving schools the measure of effort may be seen as very different from a small rural school.
- ***CLASS:*** The classroom variables tended to not be statistically significant with only class size showing a positive, statistically significant relationship in one regression model.
- ***TEACHER BACKGROUND:*** Surprisingly few teacher background variables were statistically significant. Only gender was statistically significant across models, where female teachers had a positive and statistically significant relationship with student mathematics scores. Years of experience, which had a simple correlation being positive and statistically significant in model 1.1, did not remain statistically significant in subsequent models. While the simple correlation of civil servant teachers had a strong, positive relationship with student mathematics scores, this did not hold true in the regressions.

6.2.2. Analysis of Relationship between Teaching Practices and Student Mathematics Scores

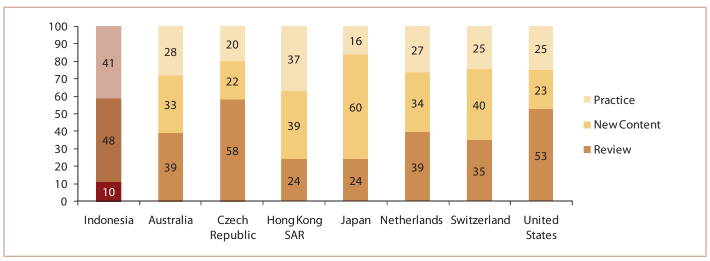


Structure of Time

In looking at the structure of class time, students in classes that were longer and had more time dedicated to mathematics tended to score higher on examinations while classes with a lot of non-mathematics time tended to score lower. While it may seem intuitive that more time spent in class would result in higher scores, it also goes against one concern that arose out of Indonesia's lengthy classes (70 minutes on average) which may be too long for keeping the attention of 8th graders. The results in Table 6.5 below, however, indicate that students in longer classes tended to have higher mathematics scores. As noted in the earlier sections, Indonesian classes spent relatively more time for non-mathematical activities (3%) compared to other countries (1%-2%). The results showed a statistically significant negative relationship between mathematics scores and non-mathematics time, both in terms of total time and as a percentage of class time.

Table 6.5 T-statistic results for structure of time

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Total class time	1.40	1.94	2.18	1.66	2.57	2.63	1.58
Total time for mathematics	1.65	2.24	2.37	1.96	3.07	2.98	1.87
Total time for non-mathematics	-2.17	-2.55	-1.94	-1.28	-2.43	-1.96	-1.48
Total time for mathematical organization	0.03	-0.03	0.11	0.50	-0.12	0.12	0.36
Percent of time for mathematics	1.24	1.17	0.83	0.11	1.49	1.04	0.34
Percent of time for non-mathematics	**-2.60**	**-2.71**	-2.18	-1.44	**-2.85**	-2.45	-1.83
Percent of time for mathematical organization	-0.30	-0.25	-0.11	0.44	-0.52	-0.16	0.33

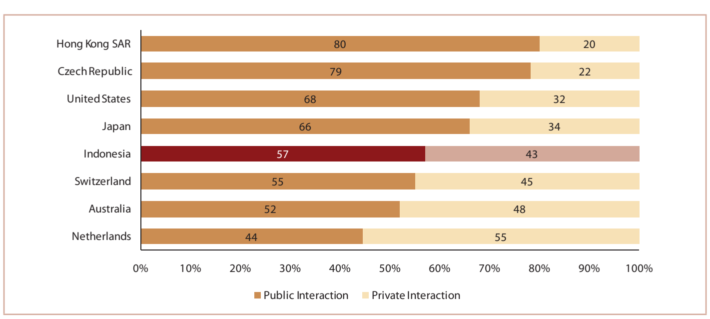


Purpose of Lesson Segment

The relationship between percent of time spent on review and assessment with mathematics scores was positive and statistically significant. Indonesia spent significantly less time on review compared to other countries, but the results indicate that students in classes that dedicated a larger percent of the class to review tended to score higher. Assessment was also not often seen in the videos, but students in classes that spent a larger portion of time on assessment tended to score higher. Practice and new content tended to be negative, but only showed up as statistically significant in two of the models.

Table 6.6 T-statistic results for purpose of lesson segment

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Percent of time for review	2.44	1.73	2.39	2.18	1.48	2.23	1.93
Percent of time for new content	-0.46	-1.16	-1.69	-1.14	-1.08	-1.54	-0.79
Percent of time for practice	-0.77	-0.04	0.25	-0.26	-0.18	0.06	-1.68
Percent of time for assessment	1.05	1.74	1.28	0.97	2.10	1.74	1.36

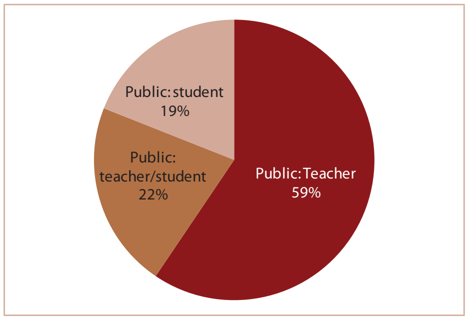


Public (full class) and Private (individual and group) Interaction

Classes that spent more time overall (in absolute terms) on public interaction tended to have higher test scores, but there was no relationship between scores and *percent* of class time spent on public vs. private interaction. Public interaction showed a strong positive relationship with test scores in all models, but the fact that this relationship disappeared when looking at percent of class time may indicate that the longer classes simply tended to have more public interaction and that the higher scores were related more to amount of time than to structured proportions of the classes.

Table 6.7 T-statistic results for public (full class) vs. private (individual and group) Interaction

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Public interaction	1.82	2.09	2.49	2.64	2.25	3.03	2.82
Private interaction	0.24	-0.09	-0.17	-0.23	0.33	-0.13	-0.23
Percent public interaction	-0.82	1.03	1.27	1.23	0.80	1.43	1.36
Percent private interaction	0.82	-1.03	-1.27	-1.23	-0.80	-1.43	-1.36

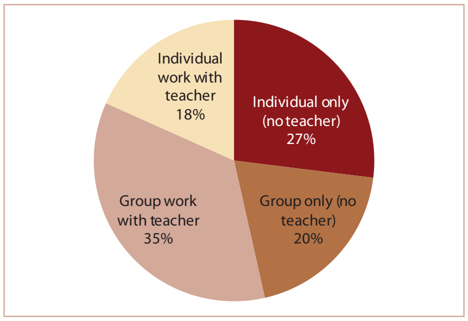


Focus on public interaction only

Classes that involved more teacher-only public interaction tended to have lower mathematics scores, while classes with more student-only and student-teacher public interaction had higher mathematics scores. When examining the breakdown of time for public interaction (Table 6.8), a pattern emerged. When the time involved the teacher only (lectures), there was a statistically significant negative relationship with mathematics scores. When it involved both teacher and student, there was a statistically significant positive relationship. When it involved students only, the relationship was also positive (but is only statistically significant in two of the models). Such results generally indicate that there is a positive relationship between mathematics scores and classes with more active student participation.

Table 6.8 T-statistic results for types of public interaction

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Public: percent teacher only	-1.66	-1.57	-1.57	-2.08	-1.92	-1.63	-2.41
Public: percent student and teacher	0.39	0.19	1.67	2.17	0.35	1.77	1.72
Public: percent student only	1.51	1.48	0.93	1.02	1.73	1.13	2.90

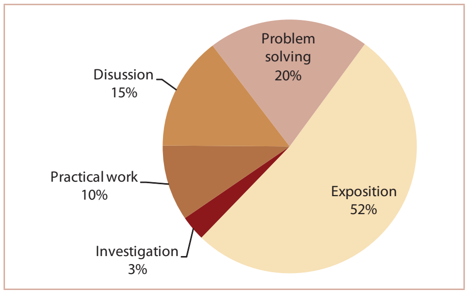


Focus on private interaction only

There is no consistent pattern when looking at the breakdown of time for private interaction. The percent of group time with no teacher assistance tended to be negative and, in some cases, statistically significant. Otherwise the results provided very few insights.

Table 6.9 **T-statistic results for types of private interaction (as percentages of total private interaction)**

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Private: percent individual time with teacher	-1.93	-0.17	0.43	0.73	-0.08	0.05	0.31
Private: percent group time with teacher	0.60	0.03	0.15	0.37	-0.14	0.07	0.45
Private: percent individual time, no teacher	1.10	1.42	0.72	0.77	1.66	1.05	1.05
Private: percent group time, no teacher	-0.01	-1.13	-1.36	-1.93	-1.33	-1.20	-1.70

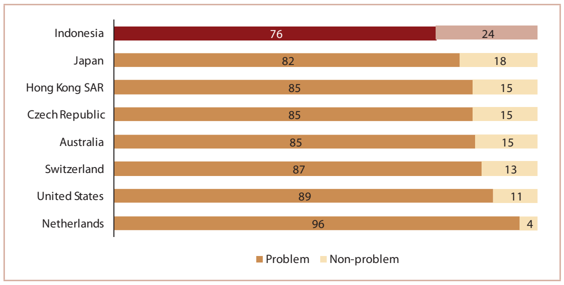


Teaching Strategy

There was very little that stood out in terms of the statistical significance for different types of teaching strategies. As shown in *4.4.1 Teaching Strategies*, the most common strategy was exposition, with a proportion of 52% of all teaching strategy time. Exposition tended to be positive, but not statistically significant. Overall, no teaching strategy emerged as having a clear relationship with student mathematics scores. This result may be due to the fact that the analysis didn't focus on teaching strategies for specific activities. For example, exposition may tend to be more effective in presenting new material but less effective when conducting review. It may also be an indication that teaching strategies are complex and that the effectiveness of techniques cannot be captured through regression analysis, but instead must be analyzed through how the teacher chooses the appropriate strategy as well how the strategy is applied. Finally, from the review of the videos, it is clear that for each strategy there are teachers who use it effectively and others who are less effective. For teaching strategies in particular, effectiveness may not necessarily be based on *what* the teacher does but *how* the teacher does it. More in-depth analysis of this area will be performed in subsequent phases.

Table 6.10 **T-statistic results for teaching strategies**

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Percent of time for discussion	-0.50	0.08	-0.05	0.05	0.06	-0.18	0.06
Percent of time for exposition	0.25	0.93	0.90	0.06	0.59	0.80	-0.15
Percent of time for investigation	1.21	0.03	-0.16	-1.64	0.80	0.56	-0.45
Percent of time for practical work	0.67	-0.13	-0.25	0.27	-0.13	-0.25	0.20
Percent of time for problem-solving	-0.76	-1.03	-0.52	0.29	-1.05	-0.65	0.07



Problem vs. Non-Problem Time

Students in classes where teachers dedicated a larger proportion of time to problems tended to have higher mathematics scores. Indonesia spent 24% of mathematics time on non-problem activities, which is significantly more than other countries which spent between 4% and 18%. The average percentage of mathematics lesson time that was devoted to problem segments tended to have a positive relationship with mathematics scores and showed up as statistically significant in all models while time devoted to non-problem segments had a negative relationship, although it was statistically significant in only half of the models.

Table 6.11 T-statistic results for problem and non-problem time

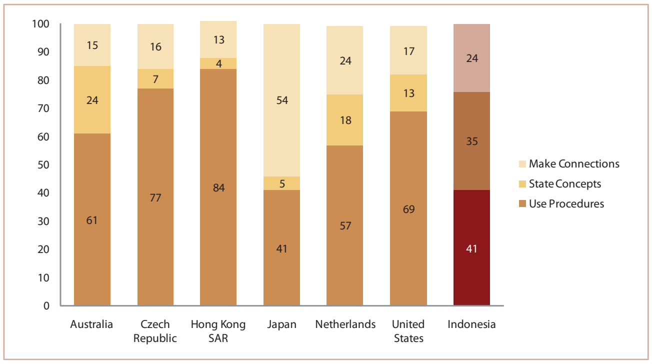
Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Problem time	-0.32	2.50	3.07	1.92	3.22	3.74	2.23
Non-problem time	-1.80	-1.77	-1.57	-1.92	-1.49	-1.28	-1.74

Use of Applications and Proofs

Students in classes where a larger number of proofs were introduced tended to have higher mathematics scores. These results were statistically significant for all except the models including provincial variables. On the other hand, the results were not statistically significant regarding the number of problems with applications. Both techniques would be considered more advanced forms of problem solving, so the fact that there was not a statistically significant relationship between mathematics scores and the use of applications would go against the expected result.

Table 6.12 T-statistic results for use of applications and proofs

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Number of problems with applications	-0.58	-0.46	0.03	-0.66	-0.34	0.25	-0.68
Number of problems with proofs	1.95	1.88	1.74	0.51	1.97	2.07	0.72



Method for Setting up Problems

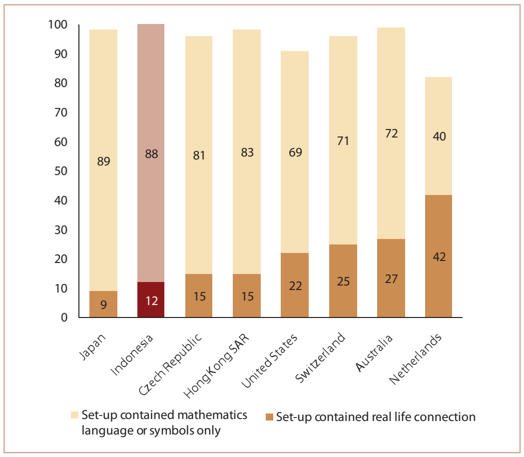
There was a positive and statistically significant relationship between student test scores and classrooms that had a higher percentage of problems that involved making a connection. This result is logical in that the technique of making a connection is typically a more complex and challenging method for setting up problems. In this case the causal direction is particularly ambiguous because it is likely that teachers with more advanced classes may simply have more opportunities to use this technique more often, but that the technique may or may not contribute more to students' ability to learn. Alternatively, it is also possible that higher ability teachers are better able to set up problems using connections.

Table 6.13 T-statistic results for methods for setting up problems

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Percent of problems making a connection	-0.20	2.38	1.74	1.13	1.78	1.77	1.38
Percent of problems stating a concept	0.38	0.28	0.53	0.72	0.47	0.53	0.67
Percent of problems using a procedure	0.31	-0.80	-0.97	-1.07	-0.95	-1.04	-1.03

Mathematics Language vs. Real World Context

Classes where problems were often discussed using mathematics language and symbols tended to have higher mathematics scores than those tending to use real life contexts. This result goes counter to some theories which encourage the use of real life mathematics (e.g. Bottoms and Sharpe, 1996) as well as Indonesia's



program of Contextual Teaching and Learning (CTL). In addition, an Asian Development Bank study found that in Indonesia, 60% of the learners are contextual learners (as opposed to conceptual learners), with contextual learners needing extra clarification in order to understand concepts taught by the teacher (ADB, 2001). One important point about the TIMSS testing instrument is that it was designed with more of a mathematics language, symbols and procedures orientation. This can be contrasted with the Program for International Student Assessment (PISA) which is designed from the perspective of applying mathematics to real life situations. The positive relationship found between mathematics scores and the use of problems with mathematics language and symbols may indicate that students in classes that tended to use this problem approach were better prepared for TIMSS questions, but the result may be quite different if the questions were similar to PISA.

Table 6.14 T-statistic results for types of mathematics problem language

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Problems with mathematics language and symbols	2.34	3.50	4.01	3.64	3.70	3.93	3.02
Problems with real life context	-0.84	-1.91	-1.29	-2.06	-1.68	-1.11	-1.94

Use of Instruments/Tools

Students in classes where a projector was used tended to have higher mathematics scores, while classes that used textbooks tended to have lower mathematics scores. The following data was gathered through observation so these variables capture whether the instruments were used at the time the class was observed. The students in classes that used a projector during the lesson tended to have higher mathematics scores, with the relationship being statistically significant in the last three models. Students in classes that used textbooks or alternative books tended to have lower mathematics scores, and the relationship was statistically significant in all models. The use of mathematics materials also tended to be negative and statistically significant. These results may not reflect on the quality or usefulness of the textbooks or materials themselves but could instead be due to less experienced or capable teachers having to rely more on them. More experienced or capable teachers may be able to develop and conduct lessons with less need for supporting materials.

Table 6.15 T-statistic results for the use of instruments during class

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Use projector	2.31	0.22	0.37	0.35	2.59	2.67	3.61
Use textbook	-1.80	-2.04	-2.12	-1.85	-1.70	-1.83	-1.68
Use alternative books		-2.45	-2.48	-2.05	-2.31	**-2.92**	-2.48
Use mathematics materials	0.72	-0.79	-2.28	-1.93	-0.84	-2.35	-1.97
Use calculators	-2.43	-0.89	-0.77	-0.34	-1.14	-1.12	-0.70
Use real world objects	-0.01	-0.51	-0.55	-0.60	-0.69	-0.46	-0.58

Lesson Planning

In lesson planning, the students in classes with teachers that specified they spent more time developing the lesson plan and/or had developed it with another teacher tended to have higher mathematics scores. Other categories did not show a strong pattern.

Table 6.16 T-statistic results for lesson planning

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Time developing lesson plan beforehand	0.87	0.7	0.55	1.61	3.04	4.19	2.08
Lesson plan development with other person	1.85	1.9	1.66	2.02	2.64	2.05	0.77
Lesson plan development with a group	1.74	1.59	1.35	0.93	0.13	0.04	-1.29
Time for developing lesson plan	0.82	-1.09	-0.63	-0.53	-0.06	-0.6	-1.54
Evaluation score of teacher's lesson plan	1.66	0.68	0.36	1.49	1.25	1.38	0.62

Teacher Influences

Teachers who said their lessons were influenced by the curriculum and national test tended to have classes with higher mathematics scores. Teachers were asked, on a scale of 1 to 3 (none, some, a lot), to what degree they were influenced by various items. There was a strong positive relationship between mathematics scores and teachers who said they were influenced by the curriculum. There was also a positive relationship between mathematics scores and teachers who said they were influenced by the national test.

Table 6.17 T-statistic Results for Teacher Influences

Variable	Covariance	R 1.1	R 1.2	R 1.3	R 2.1	R 2.2	R 2.3
Teacher influence by curriculum	2.18	3.06	2.53	2.68	3.37	3.38	2.60
Teacher influenced by national test	1.60	2.31	2.06	2.09	2.41	2.13	2.27
Teacher influenced by reference book	1.22	1.20	0.85	0.60	1.25	1.06	0.65
Teacher influenced by teacher interest	1.32	0.77	0.34	0.46	1.16	0.45	0.12
Teacher influenced by student interest	0.44	0.45	0.10	-0.01	0.67	0.38	0.16
Teacher influenced by colleague	0.70	0.10	-0.46	-0.35	0.00	-0.88	-1.39

6.2.3. Summary of Regression Results

As was stressed earlier, the regression results presented here must be viewed as simply identifying patterns and relationships between student mathematics scores and teaching techniques. They should not be interpreted as showing any causal effects. It is also important to stress that, because the mathematics scores are for a single test and students build up their mathematics abilities over the course of many years while working with various teachers, attributing student test results solely to the teaching techniques of the 8th grade mathematics teachers would be a presumptuous leap. In order to address these weaknesses, the 2011 phase of the study will include additional before- and after- tests for participating students. At this stage, the relationships should be viewed only as providing initial insights into the link between teaching practices and student mathematics scores.

Even with keeping the analysis limitations in perspective, many interesting results emerged. Indonesia has been pursuing a policy of more student-centered learning, and various indicators of classes where students are more involved and active emerged as having a positive relationship with student mathematics scores. Classroom management practices also emerged as positive, where classes that had more time dedicated to mathematics activities and problem time tended to have higher test scores. How mathematics is approached may also be related to mathematics scores, with having problems that make a connection, setting up problems with mathematics language and symbols, and having problems that involve proofs all tending to have positive relationships with test scores. How teachers prepare their lessons may also be related to student learning, with teachers using lesson plans prepared beforehand and lesson plans prepared with others being positive. Relationships also emerged related to what tools are used in the classroom, with classes using projectors being positive while classes using textbooks had a negative relationship. Teacher influences also play a role, with students in classes where teachers state that their lessons are influenced by the national curriculum and national examination tended to score higher.

These insights are an initial step in understanding the linkages between teaching techniques and classroom practices with student mathematics scores. Many of the resulting relationships are supported by theories of good practice in teaching. The results also help in understanding the relationships that may exist within the context of an Indonesian classroom rather than classrooms in general, since cultural factors make effective teaching and learning contextual rather than universal.

The insights are a foundation for additional analysis of rather than a final answer about, on effective teaching practices. Within each activity, examples of what are likely to be effective or ineffective teaching can be found. For example, just because review of previous material had a positive relationship with student test scores doesn't mean that simply increasing the time dedicated to review of previous material will lead to increased scores. It is much more important what the teacher does within the activity and how the teacher engages the students rather than the amount of time spent. The results do point to what activities appear to be important, though, and help in determining where to focus additional research.

This study is continuing with the analysis of the 2007 data and will also include a 2011 phase. The results have provided a strong basis for additional qualitative analysis in the areas of teacher-student dialogue, how teachers pose questions, classroom management, student engagement and innovative use of tools. The results have also been integral in enhancing the design for the 2011 phase, which will involve case studies and will probe into teacher beliefs and orientation towards mathematics teaching as well as the role of how teacher subject knowledge and pedagogical skills shape what takes place in the classroom. It is hoped that the study results will spur further research that can help improve the effectiveness of what takes place in Indonesia's classrooms.

Section 7

Summary and Implications

The findings in the last section provide a rich picture of Grade 8 mathematics teaching in the Indonesian classroom. From the results, we can identify a number of positive aspects as well as potential areas for improvement of mathematics teaching in Indonesia when compared with other countries in the TIMSS 1999 Video Study and through analysis of the relationships between teaching practices and student outcomes.

7.1. Positive Aspects of Mathematics Teaching in Indonesia

Many positive results emerged from the analysis, indicating that Indonesia is employing many good practices. In many cases, the results surpass those of other countries. Among the results:

- The classroom environment is often conducive to learning, and mathematics teaching in Indonesia is mainly conducted with few outside interruptions.
- Indonesia has relatively more lessons with goal statements and lesson summaries which should lead to improved clarity and flow of the lessons.
- Although only a few problems were categorized as high complexity, a large proportion of problems are of medium complexity, with relatively few of low complexity when compared to other countries.
- Students are given ample opportunity of practicing what they have just learned in the lessons.
- Compared to other countries, students have more time working in small groups.
- There is more use of real-life objects in the lessons than in comparator countries.
- Relative to other countries, a larger proportion of teachers use the set-up approach of making a connection, and this approach was found to have a positive relationship with student mathematics scores.

7.2. Potential Areas for Improvements in Mathematics Teaching

The findings of this video study also point to some areas for improvement in the mathematics classroom organization and instructional practices in Indonesia:

- The duration of grade 8 mathematics lessons is rather long compared to other countries. As a result, students may not be able to concentrate on the subject matter to be learned for the whole duration of the lesson.
- Relative to other countries, much more lesson time is spent on non-mathematical and mathematical

organization work with a result that less lesson time is spent on teaching and learning mathematics. The amount of time spent on non-mathematical activities has a negative relationship with student mathematics scores.

- Within mathematical time, Indonesian teachers spend comparatively less time on problems, and students from classes that have relatively more non-problem time tend to score lower.
- Comparatively less time is spent on reviewing what has been learned in past lessons before going on to introducing now content although there is a positive relationship between classes that spend more time on review and student mathematics scores.
- Assessment is relatively rare, but students in classes that have more assessment time tend to have higher mathematics scores.
- Relatively little homework is given, and much lesson time is consumed on practicing.
- Both teachers and students speak relatively few words in the lessons, and the lengths of their utterances are short in general.
- The ratio of student words to teacher words is very low compared to other countries.
- Very few of the mathematics problems dealt with are of high complexity.
- There are few problems involving applications.
- The choice of different solution methods is not stressed, with most teachers only focusing on a single solution to problems.
- Not many students have the chance to examine the methods of solution of problems.
- Calculators are rarely used in the classrooms.

7.3. Additional Observation Notes from the Videos

Beyond the coded videos, additional observations were made by the core team regarding teaching practices in Indonesia. Although the coding of the videos provides for objective data analysis, it cannot always capture what the observers of the videos could see. The study team (who are mathematics experts and practitioners themselves) noted interesting patterns and felt that certain activities were not being properly conducted. Recommendations included:

- There is a need to apply *better time management in the classroom* and to use the time effectively *to teach relevant content*
- More emphasis should be put on *higher order thinking* in the instructional delivery
- There was often a mismatch in level of *content coverage* (the level and the amount of the content covered is equal to the level and the amount understood by a student)
- There is a need to create a more stimulating environment that will maintain *student engagement and involvement*

7.4. Implications for Educational Policies

While any policy measures to be taken need to ensure that the many strengths of mathematics teaching in Indonesia as listed above are not lost, the various deficiencies above point to some specific improvement measures.

While this upgrading of qualification exercise introduced by the Teacher Law is in the right direction and should be applauded, it is important to remember that mere upgrading of qualification is not sufficient for high quality teaching. In particular, the educational background of teachers should match the subjects that they are teaching. In the event that this is not the case, in-service professional development activities need to be provided to make sure that the teacher is able to build on his/her qualifications to develop expert knowledge in the field that he or she is teaching.

The relevant authority should review the organization of lesson time. Seventy minutes per lesson may be too long for children of Grade 8 (although the regression results indicate that longer classes actually have a positive relationship with mathematics scores). More importantly, measures need to be taken to reduce the organization work of the teacher during the lesson so that more time can be devoted to the most important activity in the classroom – that of teaching. Possibly a piloting of more but shorter classes could be conducted and set up to determine which is more effective in terms of both student outcomes and teacher and student satisfaction.

The policy for the use of calculators in mathematics examinations should be reviewed. The calculator is not merely a calculation device. When used properly, it is an extremely useful tool for learning (e.g., in exploring number patterns) (Fey and Hirsch, 1992). And if graphing calculators are utilized, it contributes even more positively to mathematics teaching and learning (e.g., in linking algebra and geometry) (Ruthven, 1990; Embse, 1992; Shoaf-Grubbs, 1995; Penglase and Arnold, 1996; Doerr and Zangor, 2000). Examination policies have strong backwash effects on teaching, especially for a country such as Indonesia which puts a strong emphasis on public examinations. So in order to enhance mathematics teaching and learning in the classroom through the capitalization of the strengths of the calculator, a review of the calculator policy in examinations is important.

The policy of promoting student-centered learning appears to be a valid approach in the Indonesian context, with the more student-centered classes tending to have higher mathematics scores. The relatively low number of both teacher and student words compared to other countries, as well as the relatively high amount of teacher speaking time compared to student time, indicates that the student-centered approach is not being implemented in many classrooms. Methods to further promote student-centered learning in mathematics should be pursued.

Teacher training and supervision programs could leverage both the results of the video study and the videos themselves to enhance teacher training programs. Visually witnessing effective and less effective practices can be a powerful teaching method. Other countries that conducted the TIMSS video study have incorporated the videos into training activities; Indonesia could do the same. The videos could also be leveraged to train head teachers and supervisors who are involved in assessing and providing feedback to teachers.

7.5. Implications for Teachers

As pointed out above, many of the problems dealt with in the Indonesian classroom were of low complexity. While the teacher should always pitch the level of difficulty and complexity of the subject matter towards the level of the students, care needs to be taken not to repeatedly reduce the difficulty level of the content. This is an endless retreat and in the end not conducive to enhancing student achievement. In particular, proof and applications are both important characteristics of mathematics and should occupy a proper place in mathematics teaching and learning. Mere procedural problems are not enough to raise the achievement level of students.

Developing flexibility in the approach to the solution of problems is an important aim of mathematics education. This can be enhanced by discussing more with students different ways of tackling problems (examining methods) and by encouraging different solutions to the same mathematical problem.

Communication in mathematics is another important aim of mathematics education. A noticeable finding of this study is the reticence of both teachers and students in the Indonesian classroom. While this may be rooted in the Indonesian culture itself, teachers need to realize the importance of communication in the learning of mathematics. Students need to be given the chance and the encouragement to express themselves verbally, in addition to in writing. They should be encouraged to talk more and in longer phrases or sentences.

In this regard, the teachers themselves also need to talk more and in longer sentences to stimulate students and to act as role models for their students.

Assessment and review activities are very rarely used, but both appear to have a strong positive relationship with student mathematics scores. The increased use of assessment may assist in increasing student learning. Review of previous material (homework, etc.) may also be important to stress continuity between lessons as well as to reinforce key concepts.

Lesson planning activities are an important aspect of successful teaching. Teachers who spend more time on lesson planning tend to have students scoring higher. Working with another teacher on the lesson plan also has a positive relationship, possibly indicating that lesson planning activities conducted in teacher working groups are beneficial.

More efficient and targeted classroom management could lead to improved outcomes. There is a positive relationship with teachers who spend less time on non-mathematical activities and spend more of their mathematical time on problem activities and student test scores.

Indonesian students have very little homework relative to other countries. At the same time, a large amount of class time is devoted to conducting practice activities. While practice in class can have the benefit of students being able to directly discuss problems with the teacher and other students, it appears that class time is often being used to conduct practice that could be done in the form of homework.

7.6. Concluding Remarks

In any analysis of student achievement in Indonesia, the complexities of teaching must be kept in mind. There is not a single, correct way to teach mathematics, and this report is not intended to define a magical combination of teaching techniques to be used in Indonesia. Each classroom is different. It is critical that teachers be able to understand their own classroom situation, including the level of ability and specific needs of their students and the context in which mathematics will be most useful and understandable to them, and then be able both to use teaching practices that will best fit within that context and to adapt those practices dynamically as the needs of their students change over time. This requires training teachers to be, above all, "reflective practitioners" of their own work, able to see themselves and assess their own performance in the classroom – and to be able to help other teachers do the same.

The abundant data generated from the video study has already provided rich information on Grade 8 mathematics teaching in Indonesia, and the comparison with results of the TIMSS 1999 Video Study and the regression analysis have pointed to important policy and classroom implications for the country. This is the first phase of the two-phase study, which will be followed with a replication study in 2011. The full results will prove to be even more powerful in informing policy and practice.

Appendix

Appendix 1: Indicators for the Preliminary Research Questions

Research questions	Indicators: teacher behavior or teacher actions to bring about the relevant student behavior
1. Does the teaching help students understand mathematics concepts?	1. Giving alternative representations of a concept 2. Classifying objects based on specific characteristics 3. Giving examples and non-examples of a concept
2. Does the teaching enhance student communication in mathematics?	1. Presenting mathematics statements in written form 2. Presenting mathematics statements verbally 3. Presenting mathematics statements using tables/ pictures/ diagrams, etc.
3. Does the teaching enhance student ability in reasoning?	1. Making a reasonable hypothesis 2. Testing a hypothesis 3. Drawing correct conclusions 4. Showing a proof or giving reasons for a mathematics argument 5. Checking the validity of an argument 6. Finding patterns or making generalizations in mathematics
4. Does the teaching help develop student ability in problem-solving?	1. Organizing and/or reorganizing data 2. Discussing the choice of relevant information in solving a problem 3. Applying alternative methods in solving the same problem 4. Discussing the choice of approaches or methods in solving a problem 5. Discussing general problem-solving strategies 6. Developing and/or interpreting a mathematics model of the problem 7. Solving non-routine problems 8. Checking the procedure and/or solution of a problem 9. Looking back and/or drawing lessons after solving a problem
5. Does the teaching enhance student competence in applying mathematics procedures?	1. Doing mathematical manipulations 2. Applying suitable algorithms to solve a given problem 3. Practising mathematics skills

Appendix 2: Indicators and Data Sources for the Research Questions

Questions	Indicators	Sources of Data	Code	Planned Analysis
1. How do teachers prepare before teaching?	Lesson planned systematically	Lesson plan	LP (look at LP rubrics for teacher certification)	Use Excel to encode and analyze data
	Lesson based on the curriculum	Curriculum guide and lesson plan	LP	Use Excel
	The time teachers need to prepare recorded lesson		TQ 2 #10, 11	
	Time for teacher preparation of typical lesson			
2. Whatis the mathematics content?	Mathematics content taught	Lesson plan (or observation report)	LP, OR	Use Excel and Studiocode
3. What are teachers' abilities/competencies in teaching mathematics?	Accuracy (easier to code misconceptions)	Vdeo	Under non-problem branches	Excel & Studio
	Encourage student's reasoning skills (proof, connection)	Video	Under problem branches	Studiocode
	Encourage student communication skills (student public interaction, group individual interaction, group and teacher individual interaction, student and teacher public interaction)	Video	Student and teacher public interaction, student public interaction, group interaction, teacher&group interaction	Studiocode
	Encourage student problem-solving skills (strategi pemecahan soal/ problem)	Video	Problem-solving strategy and investigation strategy (see also how students work on problems)	Studiocode
	Encourage student skills to work cooperatively	Video	group interaction, teacher&group interaction	Studiocode
4. How is time management during the lesson?	Time spent by class on events for (mathematics: review, new lesson, practice, assessment, non- mathematics and mathematics organization)	Video	Main tree: review, new lesson, practice, assessment, non-mathematics and mathematics organization	Studiocode

Questions	Indicators	Sources of Data	Code	Planned Analysis
5a. What types of mathematics problems do students solve?	Kind of problem (nature, context, quality, type of problem)	Video	nature, context, quality, type of problem	Excel & Studio
	Number of problems solved in class	Lesson plan and video		Excel & Studio
5b. How are mathematics problems solved?	How problems are worked on (trial and error, make a pattern, try a simpler one, working backwards, using graphs, tables, or diagrams)	Video	under how problems are worked on	Excel & Studio
6a. What teaching strategies are used by the teachers?	Strategies used (exposition, discussion, investigation, problem-solving, practical work)	Video	exposition, discussion, investigation, problem-solving, practical work	
	Teaching aids/resources used	List	List	
6b. What types of questions do teachers ask?	Types of questions (open, closed, routine, non-routine, Y/N, rhetoric)	Video	Types of questions, under exposition non problem, quality under kind of problem	
7. How do teachers assess student learning?	Type of assessment tasks/ questions	Lesson plan	LP (code based on using procedure, stating concepts, making connection, proof, real world, mathematics language, open, closed, routine and non-routine)	Excel & Studio
	Assessment results	Refer to TIMSS results	refer to TIMSS result	Excel & Studio
8.What are the indicators to show teachers' motivation to improve her/his teaching skills?	Attended seminars, workshops, MGMP meetings, trainings etc.	Questionnaire	TQ 1 # 16,17c	Excel
	Read books, articles, journals, etc., and other media materials (including online resources) pertaining to mathematics and in related areas	Questionnaire	TQ2 #3f,g,h, i,j TQ1#28*	Excel
	Tried out what has been learnt from reading, training, etc.	Questionnaire	TQ2 #3j	Excel

Questions	Indicators	Sources of Data	Code	Planned Analysis
9. What learning resources are used for supporting teaching and learning?	Text books, computers, calculators, teaching aids, VCD, LCD, OHP	Questionnaire	TQ 1 # 21 a,b,c d,e,f,g	
10. What are the profiles of teachers?	The educational background of teachers (highest level of education, subject matter)	Questionnaire	TQ 1 # 10, 11	
	Teaching experience in math	Questionnaire	TQ 1 # 12	
	Age			
	Teacher status, Gender			
11. What are student attitudes toward mathematics?	Attitude toward mathematics	Questionnaire	SQ # 16	
	Perception about mathematics	Questionnaire	SQ # 17	
	Teacher perceptions		T.I 3a	

Appendix 3: Summary of Definitions

Note: Most of the definitions come directly from the 1999 TIMSS video study in order to have common coding that allows for comparison with the other countries that participated in that study. All descriptions that come from the 1999 study are marked with an asterisk (*).

Description	Definition
Structure of Time	
Mathematical time*	Time spent on mathematical content presented either through a mathematical problem or outside the context of a problem. **Examples:** talking or reading about mathematical ideas, solving mathematical problems, practicing mathematical procedures or memorizing mathematical definitions and rules).
Mathematical organization time*	At least 30 continuous seconds devoted to preparing materials or discussing information related to mathematics but not qualifying as mathematical work. **Examples:** distributing materials used to solve problems, discussing the grading scheme to be used on a test or distributing a homework assignment.
Non-mathematical time*	At least 30 continuous seconds devoted to non-mathematical content. **Examples:** talking about a social function, beginning or ending a class with a prayer, calling the roll, disciplining a student while other students wait, or listening to school announcements on a public-address system.
Lesson Segment Purpose	
Review*	This category, more technically called "addressing content introduced in previous lessons," focused on the review or reinforcement of content presented. These segments typically involved the practice or application of a topic learned in a prior lesson or the review of an idea or procedure learned previously. Examples include: 1. Warm-up problems and games, often presented at the beginning of a lesson; 2. Review problems intended to prepare students for the new content; 3. Teacher lectures to remind students of previously learned content; 4. Checking the answers for previously completed homework problems; and 5. Quizzes and grading exercises.
Introducing new content (New content)*	This category focused on introducing content that students had not worked on in an earlier lesson. Examples of segments of this type included: 1. Teacher expositions, demonstrations, and illustrations; 2. Teacher and student explorations through solving problems that were different, at least in part, from problems students had worked previously; 3. Class discussions of new content; and 4. Reading textbooks and working through new problems privately.
Practice*	This category focused on practicing or applying content introduced in the current lesson. These segments only occurred in lessons where new content was introduced. They typically took one of two forms: the practice or application of a topic already introduced in the lesson or the follow-up discussion of an idea or formula after the class engaged in some practice or application. Examples of segments include: 1. Working on problems to practice or apply ideas or procedures introduced in an earlier lesson; 2. Class discussions of problem methods and solutions previously presented; and 3. Teacher lectures summarizing or drawing conclusions about the new content presented earlier.
Evaluation/Assessment	Exams or quizzes that are given to students in order to evaluate their knowledge.

Description	Definition
Public and Private Interaction	
Full class / Public interaction*	Public presentation by the teacher or one or more students that is intended for all students
1. Teacher interaction	The teacher lectures to all students.
2. Teacher and student interaction	Presentation made by both teachers and students (in intervals), for all students.
3. Student interaction	Presentation made by students, aimed at the teacher and all students
Small group or individual/ Private interaction*	All students work at their seats, either individually in pairs, or in small groups, while the teacher often circulates around the room and interacts privately with individual students
1. Teacher and group interaction	Students work in groups or have discussions with the teacher going from group to group to provide guidance.
2. Group interaction	Students work in groups or have discussions without teacher's guidance.
3. Teacher and individual interaction	Teachers provide individual counseling to students.
4. Student interaction	Each student works alone with no interaction with the teacher.
Student presents information*	A student presents information publicly in written form, sometimes accompanied by verbal interaction between the student and the teacher or other students about the written work; other students may attend to this information or work on an assignment privately.
Problem Solving Strategy	
Exposition	The teacher lectures while students listen and answer closed questions (with no discussion).
Discussion	The teacher and student or students discuss their own ideas about mathematics.
Problem solving	The teacher provides a problem / situation as a basis to discuss ideas in mathematics.
Practical	Equipment or situations in the real world are used to understand ideas in mathematics.
Investigation	Students explore the issues (problems) in various mathematical situations.
Problem vs. Non-Problem	
Problem*	Events that contained a statement asking for some unknown information that could be determined by applying a mathematical operation. Simple questions asking for immediately accessible information were not counted as problems. Examples of mathematical problems included: 1. Adding, subtracting, multiplying and dividing whole numbers, decimals, fractions, percents and algebraic expressions; 2. Solving equations; 3. Measuring lines, areas, volumes and angles; 4. Plotting or reading graphs; and 5. Applying formulas to solve real-life problems.

Description	Definition
Non-problem*	Mathematical work outside the context of a problem. Without presenting a problem statement, teachers (or students) sometimes engaged in: 1. Presenting mathematical definitions or concepts and describing their mathematical origins; 2. Giving an historical account of a mathematical idea or object; 3. Relating mathematics to situations in the real world; 4. Pointing out relationships among ideas in this lesson and previous lessons; 5. Providing an overview or a summary of the major points of the lesson; and 6. Playing mathematical games that did not involve solving mathematical problems (e.g., a word search for mathematical terms).
Method of Problem-Solving	
Using Procedures*	Problem statements that suggested the problem was typically solved by applying a procedure or set of procedures. These included arithmetic with whole numbers, fractions and decimals; manipulating algebraic symbols to simplify expressions and solve equations; finding areas and perimeters of simple plane figures; and so on. **Example:** "Solve for in the equation $2x + 5 = 6 - x$" was classified as using procedures.
Stating Concepts*	Problem statements that called for a mathematical convention or an example of a mathematical concept. **Examples:** "Plot the point (3, 2) on a coordinate plane" or "Draw an isosceles right triangle" was classified as stating concepts.
Make a connection*	Problem statements that implied the problem would focus on constructing relationships among mathematical ideas, facts or procedures. Often, the problem statement suggested that students would engage in special forms of mathematical reasoning such as conjecturing, generalizing and verifying. **Example:** "Graph the equations $y = 2x + 3$, $2y = x - 2$, and $y = -4x$, and examine the role played by the numbers in determining the position and slope of the associated lines" was classified as making connections.
Problem Context	
Real world*	Mathematics problems presented within a real-life context. **Examples:** "Estimate the surface area of the frame in the picture below," and "Samantha is collecting data on the time it takes her to walk to school. A table shows her travel times over a two-week period; find the mean."
Math language*	Problems presented only with mathematical language, **Examples:** "Graph the equation: $y = 3x + 7$" and "Find the volume of a cube whose side measures 3.5 cm."
Problem Type	
Closed	A form of question which can normally be answered using a simple "yes" or "no", or with a specific simple piece of information.
Open	Questions that solicit additional information from the students. They are broad and require more than one- or two-word responses.
Problem Solution Method	
Routine	Problem that could be solved directly using a formula, definition or proposition.
Non-routine	Problem that could not be solved with a routine procedure (see above), but instead had to be solved using a non-routine strategy. In a non-routine problem, the student did not initially have a specific method for solving the problem.

Description	Definition
Problem Complexity	
Low complexity	Solving the problem, using conventional procedures, required four or fewer decisions by the students (decisions could be considered small steps). The problem contained no sub-problems, or tasks embedded in larger problems that could themselves be coded as problems. **Example:** Solve the equation: $2x + 7 = 2$.
Moderate complexity	Solving the problem, using conventional procedures, required more than four decisions by the students and could contain one sub-problem. **Example:** Solve the set of equations for x and y: $2y = 3x - 4$; $2x + y = 5$.
High complexity	Solving the problem, using conventional procedures, required more than four decisions by the students and contained two or more sub-problems. **Example:** Graph the following linear inequalities and find the area of intersection: $y \leq x + 4$; $x \leq 2$; $y \geq -1$.

Appendix 4: Comparison of Full Sample Results with Subset

As specified in section *3.6 Achieved Sample and Problems Encountered*, 28 schools were found to have different students and/or teachers from those that eventually participated in the TIMSS exam. These schools were automatically excluded from the analysis linking the results of activities in the classroom to the TIMSS results since it would have invalidated the analysis. For the task of identifying what happens in Indonesia's classrooms and comparing it to other countries, though, the 28 schools still have value in providing insights into what happens in Indonesia's classrooms. The analysis was done both with the subsample of 72 classrooms as well as with the full sample of 100.[22]

Below is a table summarizing the results using both the full sample and the subset of 72 schools. As can be seen, most results are similar, but some differences emerge. In particular for the 28 classes that were removed:

- **Activity Purpose**: Much more time was dedicated to review and less on new content for the removed sample.
- **Public vs. Private Interaction**: More public time and less private time were used
    - o ***Public Interaction:*** More teacher-only public time (lecture) was used
    - o ***Private Interaction:*** Much more individual only and group-only time was used (indicating less teacher involvement)
- **Teaching strategy:** much more exposition and problem-solving work were used
- **Problem vs. non-problem time:** more non-problem time
- **Problem Set-up Type**: much more use of procedure and less use of a concept
- **Mathematics language vs. real world:** More real world language and less mathematics language
- **Routine vs. non-routine:** more routine and less non-routine

Interestingly, the regression results indicate that the 28 dropped classes tend to use the techniques negatively related with student mathematics scores more frequently than the 72 kept classes. In the case where teachers were substituted for the video, it would have been expected that higher quality teachers were replacing lower quality teachers, but the regression results tell the opposite story. These results below do not control for student, home, school, or classroom characteristics, so it is possible that these substitutions took place in, say, lower performing schools. Still, the general results are surprising, and it may be of interest to do further analysis on the types of schools/classrooms that were eliminated from the sample and the background of the teachers themselves.

22 One additional classroom was videotaped, but the students took an examination for the full classroom period. It was decided by the team to not include this class in the analysis.

	AVERAGES						PERCENTAGES (Avg. % of Each Class)					
	72 Kept	72 Kept	28 Dropped	28 Dropped	ALL 100	ALL 100	72 Kept	72 Kept	28 Dropped	28 Dropped	ALL 100	ALL 100
	Pct	**Avg**	**Pct**	**Avg**	**Pct**	**Avg**	**Pct**	**Avg**	**Pct**	**Average**	**Pct**	**Average**
TOTAL TIME		**1:11:53**		**1:06:13**		**1:10:08**						
STRUCTURED TIME		**1:11:03**		**1:05:37**		**1:09:22**		**1:11:03**		**1:05:37**		**1:09:22**
TOTAL TIME		**98.8%**		**99.1%**		**98.9%**						
Mathematics time	89.1%	1:03:32	89.8%	0:58:17	89.3%	1:02:03	89.0%	89%	89.7%	89%	89.2%	89%
Non-mathematics time	2.6%	0:01:51	2.3%	0:01:29	2.5%	0:01:45	2.7%	3%	2.3%	2%	2.6%	3%
Mathematics organization time	8.3%	0:05:55	7.9%	0:05:07	8.2%	0:05:42	8.4%	8%	8.0%	8%	8.3%	8%
	100.0%	**1:11:18**	**100.0%**	**1:04:53**	**100.0%**	**1:09:30**	**100%**	**100%**	**100%**	**99%**	**100%**	**100%**
Review	11.3%	0:07:09	17.4%	0:10:18	12.9%	0:08:02	11.0%	10%	17.7%	16%	12.9%	12%
New content	48.5%	0:30:50	42.0%	0:24:50	46.8%	0:29:09	48.1%	43%	41.8%	38%	46.3%	41%
Practice	38.4%	0:24:22	39.8%	0:23:31	38.8%	0:24:08	39.1%	35%	40.0%	36%	39.4%	35%
Assesment	1.8%	0:01:10	0.7%	0:00:24	1.5%	0:00:57	1.8%	2%	0.5%	0%	1.4%	1%
	100.0%	**1:03:31**	**100.0%**	**0:59:03**	**100.0%**	**1:02:16**	**100%**	**89%**	**100%**	**90%**	**100%**	**89%**
Individual/private	43.0%	0:27:18	37.0%	0:21:37	41.4%	0:25:43	42.4%	38%	35.8%	32%	40.5%	36%
Class/public	57.0%	0:36:09	63.0%	0:36:47	58.6%	0:36:20	57.6%	51%	64.2%	57%	59.5%	53%
	100.0%	**1:03:28**	**100.0%**	**0:58:24**	**100.0%**	**1:02:03**	**100%**	**89%**	**100%**	**89%**	**100%**	**89%**
Public: teacher	59.1%	0:21:29	64.4%	0:24:02	60.6%	0:22:12	59.5%	31%	62.4%	36%	60.3%	32%
Public: teacher/student	21.0%	0:07:39	21.3%	0:07:57	21.1%	0:07:44	21.6%	11%	22.7%	13%	21.9%	12%
Public: student	19.8%	0:07:12	14.3%	0:05:21	18.3%	0:06:41	19.0%	10%	14.9%	9%	17.7%	9%
	100.0%	**0:36:20**	**100.0%**	**0:37:20**	**100.0%**	**0:36:37**	**100%**	**52%**	**100%**	**58%**	**100%**	**53%**
Private: teacher-individual	18.8%	0:05:07	22.4%	0:04:52	19.7%	0:05:03	18.3%	7%	22.4%	7%	19.3%	7%
Private: teacher-group	36.5%	0:09:55	16.8%	0:03:39	31.8%	0:08:10	35.2%	13%	17.5%	6%	30.8%	11%
Private: individual only	26.1%	0:07:06	39.1%	0:08:31	29.2%	0:07:30	27.0%	10%	37.8%	12%	29.6%	11%
Private: group only	18.6%	0:05:03	21.7%	0:04:44	19.3%	0:04:58	19.5%	7%	22.3%	7%	20.2%	7%
	100.0%	**0:27:12**	**100.0%**	**0:21:45**	**100.0%**	**0:25:40**	**100%**	**38%**	**100%**	**32%**	**100%**	**36%**
Discussion	14.4%	0:09:04	10.0%	0:05:42	13.3%	0:08:08	14.5%	13%	9.8%	9%	13.2%	12%

	AVERAGES						PERCENTAGES (Avg. % of Each Class)					
Exposition	50.7%	0:31:56	57.5%	0:32:50	52.5%	0:32:11	52.2%	46%	60.7%	53%	54.5%	48%
Investigation	3.7%	0:02:21	0.0%	0:00:00	2.8%	0:01:42	3.2%	3%	0.0%	0%	2.3%	2%
Practical work	10.5%	0:06:38	9.0%	0:05:09	10.1%	0:06:13	9.7%	9%	8.4%	7%	9.3%	8%
Problem-solving	20.6%	0:12:58	23.4%	0:13:21	21.3%	0:13:04	20.5%	18%	21.1%	18%	20.6%	18%
	100.0%	**1:02:57**	**100.0%**	**0:57:03**	**100.0%**	**1:01:18**	**100%**	**88%**	**100%**	**87%**	**100%**	**88%**
Problem	77.4%	0:49:00	71.9%	0:42:04	76.0%	0:47:03	76.9%	68%	71.1%	63%	75.3%	67%
Non-problem	22.6%	0:14:17	28.1%	0:16:25	24.0%	0:14:53	23.1%	20%	28.9%	26%	24.7%	22%
	100.0%	**1:03:17**	**100.0%**	**0:58:29**	**100.0%**	**1:01:56**	**100%**	**89%**	**100%**	**89%**	**100%**	**89%**
Make connection	4.3%	0:02:07	5.9%	0:02:27	4.7%	0:02:13	5.1%	3%	4.4%	3%	4.9%	3%
Concept	59.5%	0:29:01	39.4%	0:16:23	54.5%	0:25:29	58.5%	40%	38.7%	24%	53.2%	35%
Procedure	35.1%	0:17:08	54.0%	0:22:28	39.8%	0:18:37	35.5%	24%	56.2%	35%	40.9%	27%
Showing	1.1%	0:00:32	0.7%	0:00:17	1.0%	0:00:28	0.9%	1%	0.7%	0%	0.9%	1%
	100%	**0:48:48**	**100%**	**0:41:35**	**100%**	**0:46:47**	**36%**	**68%**	**57%**	**63%**	**42%**	**66%**
Mathematics language	90.1%	0:42:05	85.6%	0:34:34	89.0%	0:39:59	89.0%	59%	3.9%	0:34:34	88.5%	13:42:40
Real world	9.9%	0:04:37	14.4%	0:05:50	11.0%	0:04:57	9.3%	6%	0.7%	0:05:50	10.2%	1:34:44
	100.0%	**0:46:42**	**100.0%**	**0:40:24**	**100.0%**	**0:44:56**	**98%**	**65%**	**5%**	**61%**	**99%**	**64%**
Routine	86.1%	0:40:48	94.0%	0:38:08	88.0%	0:40:03	86.6%	57%	4.3%	0:38:08	89.0%	13:47:09
Non-routine	13.9%	0:06:37	6.0%	0:02:25	12.0%	0:05:26	13.4%	9%	0.3%	0:02:25	11.0%	1:42:04

Appendix 5: Regression Results

Note: the regression results were determined to be too large to include within this report and are instead available in a separate file.

Appendix 6: Study Costs

As mentioned in section *3.1 Justification of a Video Study*, the use of video provides many unique advantages for understanding what takes place in the classroom, but it also tends to cost significantly more than other methods of gathering data such as interviews, questionnaires or classroom observation. This appendix is intended to be of use for those who may be considering whether to undertake a video study. Indonesia's expenditures provide insights into what design decisions and country context factors may play an influential role in determining the overall costs in a video study.

Table A6.1 below categorizes the expenses incurred for the Indonesia video study by phase. The overall cost amounted to just over $400,000. Fifty seven percent of the costs came in the *data collection* phase, which involved visits to 101 schools, typically lasted three (?) days, and involved teams made up of three individuals (two technical people and one mathematics education expert). The coding, *data analysis and reporting* phase made up approximately 13% of the total cost, with most of the expenditures resulting from the lengthy process of coding the multiple layers of video. Consultant fees over the course of the study also made up a significant proportion of the cost, mainly through international consultants.

Table A6.1

ID.	Cost Categories (by Phase)	Expenditure (USD)	% of Total
A.	**Study Preparation** (design; instrument development, training for coding of videos; sampling; piloting)	31,617	8%
C.	**Data Collection** (101 classrooms in 30 provinces; filming of two classroom sessions per teacher; administering student, teacher and schoo questionnaires)	232,216	57%
D.	**Coding, Data Analysis and Reporting** (coding of videos for multiple layers; data analysis; report writing; peer review)	51,979	13%
E.	**Dissemination**	21,739	5%
F.	**Consultant Fees** (mainly involved in design, training, analysis)		
	International	50,852	13%
	Domestic	16,729	4%
	TOTAL	**405,134**	

Each video study has its own unique characteristics which shape the overall study cost. Key design and country-specific factors for the Indonesia video study included:

- **Sample size** – with 101 classrooms, the Indonesia TIMSS study involved a relatively large sample. This design approach was chosen in order to get a representative sample of Indonesia's 8th grade classrooms. Indonesia is large and highly diverse, requiring a larger sample size than in smaller, more homogeneous countries. Most video studies have smaller sample sizes and many use a case study approach without the goal of constructing generalities.
- **Number of classroom sessions videotaped** - in the case of the Indonesia study, two classroom sessions were taped, both of which were done in a single visit. An alternative approach used in many studies is to film multiple (e.g. 10+) sessions with the goal of capturing full patterns of individual teachers over time. The increased number of sessions could increase the costs significantly, particularly if multiple visits are required.

- **Labor costs** – the Indonesia video study team included many civil servant employees from the Ministry of National Education who did not receive a salary for their participation. Some of the actual labor costs are therefore not captured in the overall expenditures.
- **Travel costs** – Indonesia is a large country and visiting the schools for the data collection typically required flights. Airfare to get the video teams out to the schools made up approximately 9% of the overall costs, ground transportation 4% and accommodation made up another 9%. Travel costs made up nearly ¼ of the overall expenditure.
- **Equipment rental costs** – video equipment made up approximately 10% of the overall costs. When computer editing and raw materials such as DVDs are included, the costs are 14%.

References

Asrijanty *et al,* Presentation of Pilot for the Video Study given to the Ministry of National Education, (August 2006)

Barber, M. and Mona, M. (2007). *How The World's Best-Performing School Systems Come Out On Top*. London: McKinsey & Company.

Clarke, D., Keitel, C. and Shimizu, Y (Eds.) (2006). *Mathematics Classrooms in Twelve Countries : the insider's perspective*. Rotterdam: Sense Publishers.

Darling-Hammond, L. (1999). *Teacher Quality and Student Achievement: A Review of State Policy Evidence*. Center for the Study of Teaching and Policy, University of Washington.

Delamont,S. and Galton,M. (1986). *Inside the Secondary Classroom*. London: Routledge & Kegan Paul.

Doerr, H.M. and Zangor, R. (2000). Creating Meaning for and with the Graphing Calculator. *Educational Studies in Mathematics*, 41, 143-163.

Embse, C.V. (1992). Concept Development and Problem-solving Using Graphing Calculators in the Middle School. In J.T. Fey and C.R. Hirsch (Eds.), *Calculators in Mathematics Education: 1992 Yearbook*. Reston, VA: National Council of Teachers of Mathematics, 65-78.

Fey, J.T. and C.R. Hirsch, C.R. (Eds.) (1992), *Calculators in Mathematics Education: 1992 Yearbook*, 65-78. Reston, VA: National Council of Teachers of Mathematics.

Filmer, D. (2006). *A Millenium Learning Goal: Measuring Real Progress in Education*. CGD Working Paper 97.

Flanders,N.A. (1970). *Analyzing Teacher Behavior*. Reading, Mass.: Addison-Wesley.

Hattie, J. (2003). *Teachers Make a Difference: What is the research evidence?* Talk given at the Australian Council of Educational Research, October.

Hiebert, J., Gallimore, R., Garnier, H., Givvin, K.B., Hollingsworth, H., Jacobs, J., Chui, A.M.Y., Wearne, D., Smith, M., Kersting, N., Manaster, A., Tseng, E., Etterbeek, W., Manaster, C., Gonzales, P. and Stigler, J. (2003). *Teaching Mathematics in Seven Countries. Results From the TIMSS 1999 Video Study,* National Center for Education Statistics, Washington DC.

Hiebert, J.S. and Grouws, D.A. (2007). The Effects of Classroom Mathematics Teaching on Students' Learning, in Lester, F.K. (ed.). Second Handbook of Research on Mathematics Teaching and Learning. Charlotte, NC: Information Age Pub Inc.

Hill H.C., Rowan, B amd Ball, D.L. (2005). Effects of Teachers' Mathematical Knowledge for Teaching on Student Achievement. *American Educational research Journal*, 42, 2, 371-406.

Ma, L. (1999). *Knowing and Teaching Elementary Mathematics*. Mahwah, N.J.: Lawrence Erlbaum Associates, Publishers.

Martin M.O. and Mullis, I.V.S. (2006). *Indonesia in TIMSS 2003: A comparison with Malaysia and Singapore of Achievement in 8th grade mathematics*. A presentation at the World Bank, May 12.
Martin, M.O., Mullis, I.V.S. and Foy, P. (2008). *TIMSS 2007 International Science Report,* Boston: International Study Center, Lynch School of Education, Boston College.
Mullis, I.V.S., Martin, M.O., Kennedy, A.M. and Foy, P. (2007). *IEA's Progress in International Reading Literacy Study in Primary Schools in 40 Countries,* Boston: International Study Center, Lynch School of Education, Boston College.

Mullis, I.V.S., Martin, M.O. and Foy, P. (2008). *TIMSS 2007 International Mathematics Report,* Boston: International Study Center, Lynch School of Education, Boston College.

National Council of Teachers of Mathematics (NCTM) Commission on Standards for School Mathematics. (1989). Curriculum and evaluation standards for school mathematics. Reston, VA: NCTM.

National Council of Teachers of Mathematics. (2000). *Principles and Standards for School Mathematics.* Reston, VA: National Council of Teachers of Mathematics.

National Research Council. (2001). *Adding it up: Helping Children Learn Mathematics.* J. Kilpatrick, J. Swafford, and B. Findell (Eds.). Mathematics Learning Study Committee, Center for Education, Division of Behavioral and Social Sciences and Education.Washington, DC: National Academy Press.

Organisation for Economic Co-operation and Development (2005). *Attracting, Developing and Retaining Effective Teachers – Final Report: Teachers Matter*. Paris: OECD Publications.

Organisation for Economic Co-operation and Development (2007). *Science Competencies for Tomorrow's World*. Paris: OECD Publications.

Penglase, M. and Arnold, S. (1996). The Graphics Calculator in Mathematics Education: A critical review of recent research. Mathematics Education Research Journal, 8(1), 58-90.

Rogers, C. R. (1983). *As a teacher, can I be myself? In Freedom to Learn for the 80's*. Ohio: Charles E. Merrill Publishing Company.

Ruthven, K. (1990). The Influence of Graphing Calculator Use on Translation from Graphic to Symbolic Forms. *Educational Studies in Mathematics*, 21(5), 431-450.

Shoaf-Grubbs, M.M. (1995). Research Results on the Effect of the Graphic Calculator on Female Students' Cognitive Levels and Visual Thinking. In L. Burton and B. Jaworski (Eds.), Technology in Mathematics Teaching, 213-227. Chartwell-Bratt.

Wright, S.P., Horn, S.P. and Sanders W.L. (1997). Teacher and Classroom Context Effects on Student Achievement: Implications for Teacher Evaluation, Journal of Personnel Evaluation in Education 11: 57-67.