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Pedagogical features that influence mathematics classroom practices – A Bruneian perspective

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Abstract

In most classrooms, each subject lesson is allocated an amount of time for teaching and learning to occur. With researchers reporting that increased lesson time did not necessarily translate to increased student learning, other methods for improving learning were investigated. This study identified the pedagogical features that influence the quality of mathematics classrooms in Brunei Darussalam through video recording and analyzing the lesson sequences of four eighth-grade classrooms. This study focused on five codes, drawn from the coding scheme used in the TIMSS 1999 Video Study that specifically looked at classroom practices influencing the lesson clarity and flow of mathematics lesson sequences. The first and second features (goal statements and lesson summary statements) may improve mathematical learning though enhancing the clarity of the key ideas presented during the lesson while the remaining three features investigated three different kinds of interruptions (outside interruptions, engaging in non-mathematical activities, and any off-topic public announcements) that may disturb the flow of the mathematics lesson. In total, 20 sets of video-recorded lessons were coded. The findings from the Brunei data revealed that 80 percent of the eighth-grade mathematics lessons contained at least one goal statement while lesson summaries were relatively uncommon (10%). Outside interruptions and off-topic public announcements were frequent at 55 percent and 45 percent, respectively. All these kinds of interruptions suggest that there may be frequent instances of uneven flow within the entire length of the mathematics lessons taught by the four participating teachers.

Introduction

Within the past two decades, the world has undergone unprecedented technological advancement. In recognition of these changes, new standards of performance have been enacted by various nations to produce a workforce to meet the current economic demands, especially in the fields of mathematics, sciences, and technology (English & Kirschner, 2016). As a result, educators are faced with increased expectations to ensure that students better meet standards of learning performance, particularly in terms of students' results in standardized assessments. For teachers and students, this has meant greater emphasis and pressure to do better in learning environments.

In mathematics education, numerous researchers have studied teachers and students alike in order to enhance mathematics teaching and learning. However, despite these innovations in pedagogical approaches, classroom practices remain similar to those decades ago. In Bruneian secondary schools for example, each class is usually assigned one mathematics teacher who instructs a class of students for a relatively brief period of time before passing the group to another teacher for instruction in a different subject area. As students progress to higher levels of mathematical education,

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teachers and students alike are expected to achieve more in the same amount of time allocated compared to when the subject content was relatively simpler. Research has shown that increased classroom time did not necessarily correlate to intended student learning outcomes (Leonard, 2001a, 2001b) thereby prompting increased research into the best method to balance greater student achievement with limited added resources.

With the expansion of computer technology alongside the introduction of video recording of classroom lessons, researchers and teachers are now able to re-examine teaching at a particular place and time multiple times. Paired with ancillary data such as teacher questionnaires, observations, and student work, this has allowed a rich and authentic resource of data for investigation into classroom practices (Shahrill, 2017, 2018; Shahrill & Clarke, 2014; Shahrill & Prahmana, 2018; Shahrill, Prahmana, & Roslan, 2018, Shahrill, Putri, Zulkardi, & Prahmana, 2018; Ulewicz & Beatty, 2001).

Therefore, this study aimed to inform mathematics classroom practices in Brunei Darussalam, in particular the pedagogical features influencing its quality, through analyzing video recordings of four eighth-grade mathematics classrooms (Shahrill, 2009, 2017). The study drew upon the coding scheme that was used in the TIMSS 1999 Video Study (the 1998–2000 Third International Mathematics and Science Video Study by Hiebert et al., 2003). The TIMSS 1999 Video Study examined and described the teaching practices in eighth-grade mathematics classrooms in seven countries namely, Australia, the Czech Republic, Hong Kong SAR, Japan, the Netherlands, Switzerland, and the United States. Among the many TIMSS codes developed, this present study specifically looked into five codes identifying pedagogical features that influenced classroom clarity and the flow of the mathematics lesson. The first and second features which were considered when looking into enhancing classroom clarity were goal statements and lesson summary statements and the other three features influencing the flow of the mathematics lessons were outside interruptions, non-mathematical segments, and public announcements unrelated to the current mathematics assignment.

Literature Review

According to Brophy (1999), the aspects of motivation of a student should be seeking to acquire knowledge (learning or mastery goals), rather than aiming to produce a performance that meets some standard of excellence (performance goals). Furner and Gonzalez-DeHass (2011) recommended the practice of mastery-oriented classrooms so that more students define success by emphasizing individual improvement, and their satisfaction is gained from placing value on effort and learning new skills. Following the definition provided by Hiebert et al. (2003), goal statements are explicitly written or verbal statements made by the teacher regarding the specific mathematical topic(s) that the teacher expected to cover during the lesson. Additionally, these statements had to preview the mathematics that students encountered during at least one-third of the lesson time. With the introduction of this type of goal statement, students engage in more effective learning strategies that are beneficial for their long-term development.

Apart from utilizing goal statements, teachers should also be more aware of the numerous advantages of summarization, one of which being the effort to identify main points, as summarizing has been shown to help students remember those ideas (Anderson & Hidi, 1988; Murrell, 1987). Summary statements usually occur near the end of the public portions of the lesson and highlight main points that were covered in the lessons (Hiebert et al., 2003). Therefore, teachers need to instruct students on how to carefully extract important key points. According to Kintsch and van Dijk (1978), there are three steps to the summarization process: deletion, generalization, and construction. The selecting, planning and integrating clearly involves students' high-order skills that they can apply not only in mathematics, but are also skills that are transferable to all other subject areas.

Whilst it is important to enhance the clarity of the lesson through the use of goal statements and lesson summary statements, teachers are encouraged to make effective use of classroom time. It was reported by the National Center for Education Statistics (NCES, 1993) that this was the single greatest influence on student learning opportunities and outcomes. However, there may be events, either within or beyond the teacher's control, that reduce instructional time in the classroom. Ranallo, Bareham, and Chandler (1997) and Leonard (2001a, 2001b) contended that time spent on school assemblies and special events, adjustments in class timetabling, unexpected or unforeseen interruptions, discipline matters, and so on meant that only a portion of allotted time was effectively used for instructional purposes.

A study conducted by Leonard (2003) found that the effect of outside interruptions was considered to be a source of concern and frustration for the majority of teacher respondents. It appeared that the origins of these interruptions did not concern teachers as much as their timing and frequency. Many spoke of repeated incidents where the distracting event diverted both the students and teachers' attention away from the class subject or activity during the lesson. Foerde, Knowlton, and Poldrack (2006) stated that the presence of such distraction would decrease the overall learning process. Other factors that cause distractions and hence reduce instructional time in the classroom include the engagement of non-mathematical segments and teachers making public announcements that were unrelated to the current mathematics assignment during the lesson.

Methodology

In order to relate the findings of the TIMSS 1999 Video Study to the practices of specific Brunei mathematics classrooms, there were certain aspects of the research design from the TIMSS 1999 Video Study that had to be carefully followed. The first was in the use of a two-video-camera approach—the teacher camera and the student camera—that focused on the whole class. Secondly and most importantly, all the significant codings from the TIMSS 1999 Video Study were strictly used in order to make possible comparative analyses of the Brunei video data with the data from the seven TIMSS countries. Although the design of the present study followed the analyses of the TIMSS 1999 Video Study closely

in terms of the coding scheme, the data generation methods also used were an adaptation of the Learner's Perspective Study, henceforth, referred to as the LPS (Clarke, Keitel, & Shimizu, 2006). That is to say, rather than video-recording single lessons as was done in the TIMSS 1999 Video Study, this study followed the LPS approach of video-recording a sequence of lessons for each participating teacher. This enabled us to generate a more substantial body of data to enable ease of comparative analyses of the Brunei video data with the large dataset of the TIMSS 1999 Video Study. Moreover, unlike the TIMSS 1999 Video Study, where typical or average teachers were video-recorded, the teachers in the LPS were regarded as competent or highly effective. Finally, in the LPS, post-lesson, video-stimulated interviews were conducted with the teachers and students, but there were no interviews done in the TIMSS 1999 Video Study.

Therefore, following the teachers for a relative longer period, ranging from four to six consecutive lesson sequences; focusing on competent teachers, and having the interviews, from the LPS research design and from the research design of the TIMSS 1999 Video Study, video recording using the two-camera approach and fully utilizing the TIMSS codes, formed the development of the conceptual framework for this present study (Shahrill, 2009, 2017).

Sample

The two secondary schools that participated in this study were chosen using convenience sampling. Apart from issues of ease of access, the choice of the participating classrooms was random. In the present study, data were collected from the four eighth-grade Mathematics classes by video recording the lessons. In total, 20 sets of video-recorded lessons were coded. In the present study, there were four participating teachers who were considered competent at teaching eighth-grade mathematics by their principal and colleagues. The teachers in the first school (BNA) were both male (T1 and T2), while in the second school (BNB), both the teachers were female (T3 and T4). At the time of study, T1, T3, and T4 were considered early career teachers with two years of teaching experience, while, T2 had six years of teaching experience. Note that the schools and teachers were coded instead of named.

Data Analysis

Before presenting the results in the following section, it is necessary to define the terminology used in reporting the data to enforce validity. Note that the term "*the* Brunei data' is used because this study included only four mathematics teachers in Brunei compared to the 50–140 teachers from various countries who participated in the TIMSS 1999 Video Study. Therefore, it is important to note that when reporting on the data obtained in Brunei, the term "*the* Brunei data" was used to represent the data collected from the four participating Brunei teachers only and should by no means to be taken as a national representation.

Additionally, in the data analysis stage, five pedagogical lesson features that influence the lesson clarity and flow were considered. The first and second features (goal statements and lesson summary statements) may influence the mathematics lesson by enhancing the clarity of the key ideas or major points given to the students during the lesson. The other three features investigated three different kinds of interruptions that may somehow break the flow of the mathematics lesson.

Results and Discussions

Goal Statements

Based on the Brunei data collected, 80 percent of the eight-grade mathematics lessons contained at least one goal statement suggesting that the teachers specifically stated the kind of mathematics the students should be expecting to cover in the lesson. This placed the results obtained from the Brunei data (80%) in between that of the Czech Republic (91%) and Japan (75%) as shown in Figure 1.

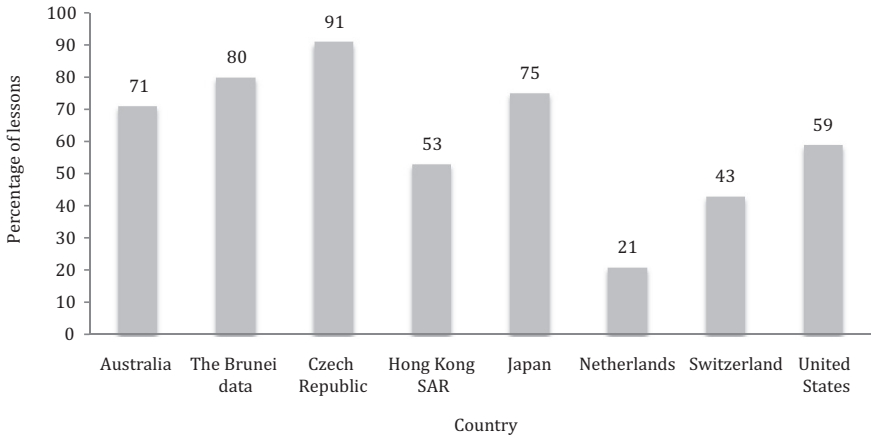

Figure 1 Percentage of eighth-grade mathematics lessons that contained at least one goal statement, by country
Notes:
The Brunei data were collected in 2006, and the Japanese mathematics data were collected in 1995.
SOURCE: The TIMSS-countries except for the Brunei data were from the U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999 (Hiebert et al., 2003).

Referring to the definition given earlier by Hiebert and colleagues, to be counted and categorized as a 'goal statement', "the statement had to preview the mathematics that students encountered during at least one-third of the lesson time" (Hiebert et al., 2003, pp. 59–60). From the video recordings of the four Bruneian teachers, there were 16 instances out of the 20 lesson sequences where the goal statements could be counted. Subsequently, only BNA-T1 and BNB-T3 conveyed their goal statements consistently in each of their lessons. Below are some of the goal statements from each of the teachers' video-recorded lessons.

BNA-T1 Today's revision is about circle … so circle has sub-topic properties of chord, properties of tangent … and angle properties of a circle. There are four angle properties of a circle ah …

BNA-T2 Actually, we are talking about a new topic called introduction to statistics [wrote 'INTRODUCTION TO STATISTICS' on the whiteboard].

BNB-T3 Pie chart ah. It's the last one … Now you've done pie chart before isn't it? What primary six?

BNB-T4 So today's lesson is on pie chart. Remember we've done …

Some words given in the statements above depict the specific mathematical topics of a given lesson, such as the properties of a circle and pie chart, and according to Brophy (1999), this can help the students in identifying the key mathematical points within a lesson, and for this study in particular in the eighth-grade video-recorded lessons.

Lesson Summary Statements

As shown in Figure 2, at least 10 percent of lessons recorded, in both the Brunei data and Australia contained at least one summary statement. This concurs with the results reported by Hiebert et al. (2003) whereby lesson summaries were less common than goal statements. This suggests that the Brunei teachers did not often provided the students with a summary statement of the mathematics lesson presented.

Referring to all the video-recorded lessons in the Brunei data, we only detected two instances of summary statements; these statements were made by BNA-T2 where he highlighted the points that had been studied in his mathematics lessons. Shown below are the transcripts between BNA-T2 and his students taken from his second and fifth video-recorded lessons, in which these occurred near the end of his respective lessons.

From BNA-T2's second lesson:

BNA-T2 Okay, what is the most important part for a frequency distribution table?

Ss The key.

BNA-T2 We need to show the?

Ss Key.

BNA-T2 The what?

Ss Key.

BNA-T2 For a frequency distribution table?

Ss Tally marks.

BNA-T2 We need to show the … tally marks. What about for a pictogram? What is the most important part for a pictogram?

Ss Key.

T2 We need to show the … key.

From BNA-T2's fifth lesson:

BNA-T2 So today, know that, for a line graph, who normally use the line graph or the line chart?

Ss Business.

BNA-T2 Business persons. And then in order for us to detect the difference that happens from one month to the other or from a day to the other and so on, and finally, the pie chart. Can you straight away construct a pie chart?

Ss No.

BNA-T2 So you have to calculate for what?

Ss The angle.

BNA-T2 To calculate the size of its angle by applying the formula of P over Q times by 360 degrees or 100 percent?

Ss 360 degrees.

BNA-T2 360 degrees. Any questions?

In agreement with Stigler and Hiebert (1999) and Hiebert et al. (2003), summarizing the lesson assisted the students in recognizing the main mathematical points within the lesson, and this can also enhance the clarity of the key ideas taught.

Outside Interruptions

The Brunei data showed that 55 percent of the lessons were interrupted, a percentage that was significantly higher than for the TIMSS-countries (Figure 3).

Specifically, the number of lesson(s) for BNA-T1, BNA-T2, BNB-T3, and BNB-T4, in which at least one interruption occurred, was 1, 2, 2, and 6, respectively. It was astonishing to see that all six of BNB-T4's video-recorded mathematics lessons contained at least one outside interruption. Some examples of interruptions recorded in the Brunei lessons were: the teacher remarking on the late arrival of student(s) into class; the school bell ringing over the intercom with the teacher commenting about it; individuals from outside the class requiring the teacher's attention, an announcement over the intercom that caused an abrupt end to the class; and some sort of interruption from outside the classroom—for instance noises coming from the roof—that disrupted the classroom activities where the students stopped working while the teacher commented about it.

Given below are explanations and discussions of a few selected episodes of the disruptions that were portrayed from the video-recorded lessons.

In BNA-T1's second lesson, someone from outside wanted to deliver something which caused several students to turn their heads toward the entrance of the classroom. Suddenly, one student closer to the door stood up to collect the document given, and BNA-T1 who was writing and verbally explaining to his students at the front of the class had to stop in the middle of explaining the process of solving a quadratic equation, then continue and then stop again to walk to his table to instruct the student to place the document on his table, and to say thank you.

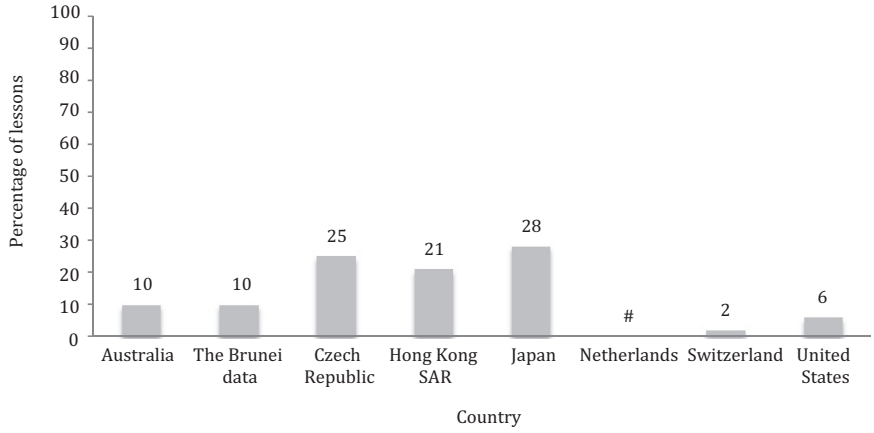

Figure 2 Percentage of eighth-grade mathematics lessons that contained at least one summary statement, by country
Notes:
The Brunei data were collected in 2006, and the Japanese mathematics data were collected in 1995.
#Reporting standards not met because too few cases were reported.
SOURCE: The TIMSS-countries except for the Brunei data were from the U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999 (Hiebert et al., 2003).

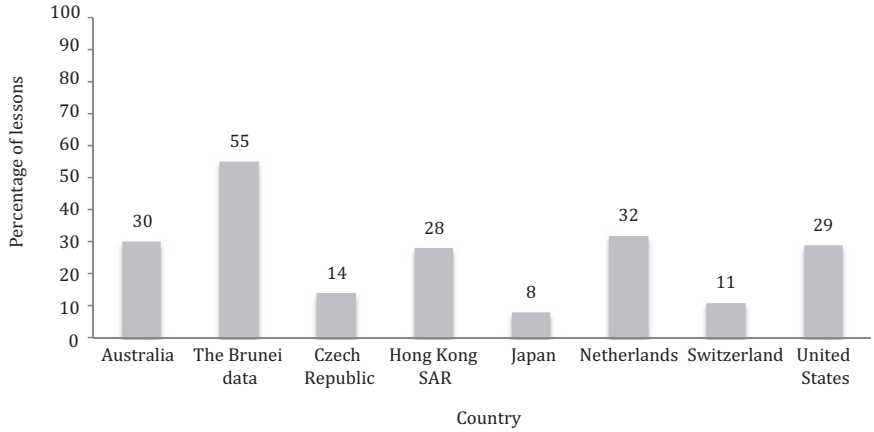

Figure 3 Percentage of eighth-grade mathematics lessons that contained at least one outside interruption
Notes:
The Brunei data were collected in 2006, and the Japanese mathematics data were collected in 1995.
SOURCE: The TIMSS-countries except for the Brunei data were from the U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999 (Hiebert et al., 2003).

In BNA-T2's second lesson, he was focused on writing a list of homework questions on the whiteboard when two students came in late to the lesson causing BNA-T2 to stop writing to ask the students where the other missing student was. According to earlier statements, the two students were called to the school's welfare office. These students then settled into their seats. BNA-T2 then proceeded to give instructions about the homework. About 30 seconds after the first interruption, two more students came in late to the lesson, which distracted the other students who were writing the list of homework questions and BNA-T2 questioned where they had been.

In BNA-T2's third lesson, an account of another interrupted episode occurred when BNA-T2 was observing (from the back of the class) two of the students who were answering a frequency distribution question and writing the solutions on the whiteboard. Suddenly, there was a loud male voice from outside the classroom saying 'Oii!', which made some students jump. Simultaneously, all students turned their heads to see what was happening and distracting them from focusing on their peers' working on the whiteboard. Additionally, even the two students at the front were distracted by this episode.

As was mentioned earlier, in all six of BNB-T4's video-recorded mathematics lessons, at least one outside interruption was coded. In her first video-recorded lesson alone, there were three instances of interrupted episodes.

1) At the start of the lesson (about two minutes into the lesson), BNB-T4 was just starting to verbally explain an example to the class when a student walked in late to the classroom and BNB-T4 had to get a copy of her notes from her table, to give to the student seated in the front row to pass to the late student. BNB-T2 immediately resumed her explanation. This episode, although it was only 10 seconds, disrupted the flow of the lesson.

2) About three minutes later, while BNB-T4 was explaining, another student came in late and again BNB-T4 had to get a copy of her notes from her table, to give to the late student.

3) Unexpectedly, about 14 minutes into the lesson, a bell sounded from the public announcement system in the class, with a student's voice saying "*Sorry for this interruption. There's one additional announcement. To all students of Year 7 and Year 8, please proceed to the auditorium now*". During this time, BNB-T4 was calling to her students to volunteer in responding to the construction of a pie chart using a protractor, on the whiteboard. Due to this announcement, BNB-T4 had to apologize, and immediately instructed the class to go to the auditorium. This abruptly ended the lesson which BNB-T4 assured would be continued in the next lesson.

Another interrupted episode in the BNB-T4's fourth lesson occurred as she was ready to start the lesson when another teacher (the class teacher) was signalling whether or not he could enter the class. The class teacher wanted to take and write up class attendance in the record book on the teacher's table. BNB-T4 had to assist the class teacher with recording those who were still absent from class. BNB-T4 proceeded to write the notes on the whiteboard and some students were distracted by the class teacher. Although this episode only took about one minute, some students were not focused on BNB-T4 at the front of the class.

All the aforementioned interruptions suggested that there may be frequent instances of uneven flow within the entire length of the mathematics lessons taught in the Brunei data. While this kind of interruption appears to be beyond the teacher's control, the following two sections investigate two other categories of interruptions where in some cases, it is within the teacher's control, particularly within the mathematics portion of the lessons only.

Non-Mathematical Segments

According to Hiebert et al. (2003), a different type of possible interruption to the lesson flow may transpire when the class engages in non-mathematical activities following the start of the mathematics part of the lesson. To be coded as a non-mathematical segment or also referred to as off-topic segments, these non-mathematics segments must be at least 30 seconds in length, and do not offer opportunities for the students to learn any mathematics (Hiebert et al., 2003; Jacobs et al., 2003).

For this kind of interruption, the result obtained for the Brunei data (15%) was not as significant as the previous finding (55% for outside interruption, Figure 3). While an outside interruption could happen at any time during the course of the lesson, this kind of interruption specifically focused on the mathematics portion of the lesson. Therefore, based on the results obtained in this study, the interruptions recorded in the Brunei lessons were mostly ones that occurred outside the mathematics portion of the lesson.

In contrast, although the percentages of eighth-grade mathematics lessons with at least one outside interruption in the Netherlands and the United States were 32 percent and 29 percent, respectively (Figure 3), the percentages of interruptions that occurred within the mathematics portion of their lessons were not significantly higher (23% for the Netherlands and 22% for the United States) as shown in Figure 4.

A few observed non-mathematical segment episodes of at least 30 seconds in the Brunei video data presented here collectively included the students greeting the teacher, followed by the recitation of a short prayer to bless the lesson; the teacher taking/checking the students' attendance and logging this in the class record book; the teacher commenting on the students coming late into class, and asking the students to confirm an earlier announcement over the public announcement system; and the teacher instructing the students to group themselves within their allocated groupings, which then led to the students carrying their own tables and chairs to form their respective groups. Similar to the reports given by Hiebert et al. (2003), this particular type of pedagogical feature might potentially interrupt the flow of the mathematics lessons, and was within the teacher's control.

Public Announcements Unrelated to the Current Mathematics Assignment

Similar to the non-mathematical segments, another kind of interruption within the teacher's control was investigated relating to public announcements. This type of interruption had to be off-topic or a remark made by the teacher of varying time length during the private work time within the mathematics lesson (Hiebert et al., 2003; Jacobs et al., 2003).

The percentage of eighth-grade mathematics lessons that contained at least one public announcement during private work time that appeared to be unrelated to the current assignment are shown in Figure 5, indicating that 45 percent of eighth-grade mathematics lessons in the Brunei data contained public announcements unrelated to the current mathematics assignment. This proportion was greater than in all the other TIMSS-countries except the Netherlands (64%).

Furthermore, a closer investigation revealed that three of the four Brunei teachers made several off-topic announcements completely unrelated to the current mathematics assignment during private work time in lessons. In total, there were 29 instances recorded for all three teachers. Only BNB-T4 made no off-topic announcements in any of her video-recorded lessons. Examples of these episodes made by the other three teachers included several instances where the teachers reminded students to do revision for the upcoming tests/examinations; students being told to keep the noise down; the teacher reminding the students to buy relevant mathematical instruments and long rulers to bring to the examination; and the teacher announcing to the students to have a good holiday break.

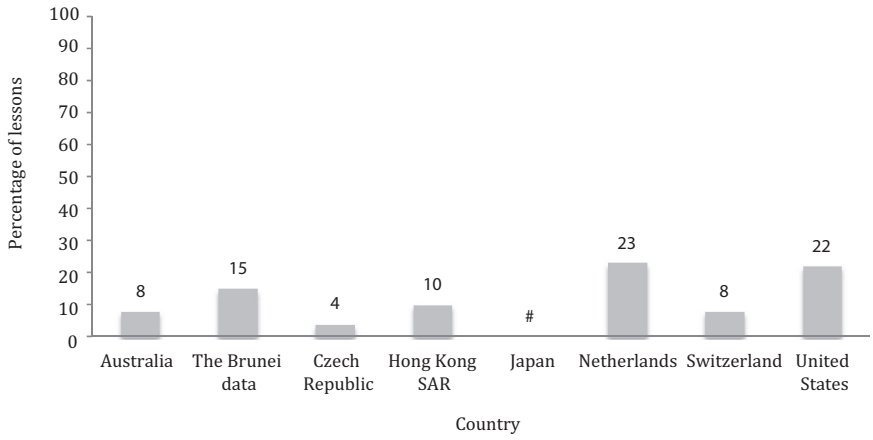

Figure 4 Percentage of eighth-grade mathematics lessons with at least one non-mathematical segment at least 30 seconds in length within the mathematics portion of the lesson, by country
Notes:
The Brunei data were collected in 2006, and the Japanese mathematics data were collected in 1995.
#Reporting standards not met because too few cases were reported.
SOURCE: The TIMSS-countries except for the Brunei data were from the U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999 (Hiebert et al., 2003).

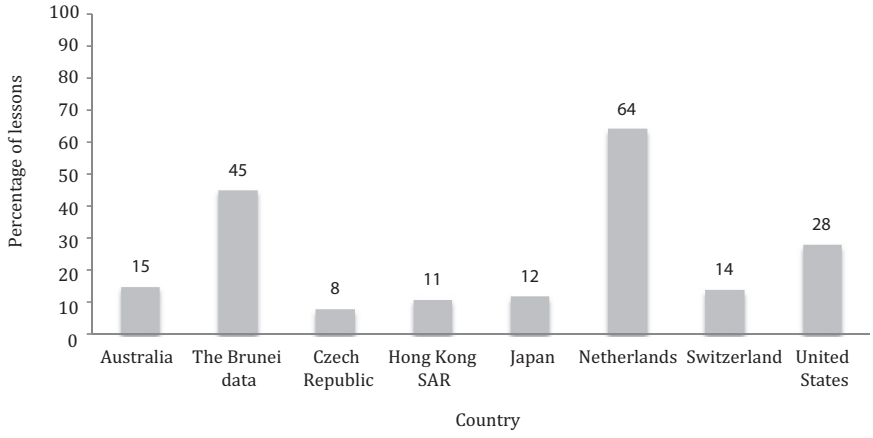

Figure 5 Percentage of eighth-grade mathematics lessons with at least one public announcement by the teacher during private work time unrelated to the current assignment, by country
Notes:
The Brunei data were collected in 2006, and the Japanese mathematics data were collected in 1995.
SOURCE: The TIMSS-countries except for the Brunei data were from the U.S. Department of Education, National Center for Education Statistics, Third International Mathematics and Science Study (TIMSS), Video Study, 1999 (Hiebert et al., 2003).

Therefore, this type of unrelated announcement could potentially interrupt the students' concentration whilst they are working on the current mathematics assignment during private work time.

Conclusion and Recommendation

The various kinds of interruptions recorded in the study suggested that the mathematics lessons taught by the four participating teachers experienced frequent instances of uneven flow where these 'interrupted' lesson times could have been used effectively for instructional purposes. Furthermore, as was depicted from the Brunei data, the participating teachers made efforts to enhance the clarity of their lessons through the use of goal statements but were less prone to provide lesson summaries.

With more time and resources, further useful research could further explore the extent to which the aforementioned classroom interruptions disrupted mathematical learning. Examining the extent of disruption may provide insights for teachers on ways to manage the classroom times more effectively and to improve their classroom practices. In addition, this study only focused on informing mathematical practices pertaining to the teachers' views. Further

investigation into students' perspectives on how they may benefit from goal statements and lesson summaries and how the previously mentioned disruptions affected their mathematical learning could perhaps provide more information for researchers and teachers alike to improve teacher education and teachers' classroom practices.

In conclusion, this study identified several pedagogical features, following the reports of the TIMSS 1999 Video Study by Hiebert et al. (2003) and its appropriate related codings by Jacobs et al. (2003), that influenced the quality of mathematical lessons within the Brunei video data. The findings of the study identified several possible areas for further investigation, particularly on students' views on best classroom practices, in order to inform researchers and teachers for improved classroom mathematical learning that is not compromised by the quality of the lesson and its settings.

Conflict of Interest

There is no conflict of interest.

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