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ORIGINAL ARTICLE

Time pressure and instructional choices when teaching mathematics

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Abstract This paper examines the anecdotal claim of "Not enough time" made by teachers when expressing their struggle to cover a stipulated syllabus. The study focuses on the actual experiences of a teacher teaching mathematics to a Year 7 class in Singapore according to a designated time schedule. The demands of fulfilling multiple instructional goals within a limited time frame gave rise to numerous junctures where time pressure was felt. The interactions between ongoing time consciousness and instructional decisions will be discussed. An examination of the role played by instructional goals sheds light on the nature and causes of time pressure situations.

Keywords Time pressure · Geometry teaching · Instructional goals · Problems of teaching

Introduction and background

The chorus of "Not enough time" is a common refrain among mathematics teachers. This sense of time constraints appears to be shared by many across different parts of the world. Kaur and Yap (1998) interviewed 22 mathematics teachers from seven secondary schools in Singapore on their perceptions of what hindered effective teaching. Most teachers highlighted the problem of heavy workload coupled with insufficient resources. In particular, they felt that there was "too much to teach in too short a time" (p. 61). In the United States of America, Manoucherhri (1999)

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surmised that teachers faced numerous demands, so much so that instructional improvisations became seen as "yet another addition to an already crowded daily schedule" (p. 38). It appears that the tension faced by teachers of having too much to do and teach with inadequate time to do so is a concern that is not restricted by geographical and cultural boundaries.

While teachers' experience of time pressure is not a new phenomenon, it has in recent years been cited as a significant obstacle in the carrying out of novel instructional approaches in the classroom. Keiser and Lambdin (1996) argued that reform-oriented teaching involves the introduction of classroom innovations such as student-centred learning, group work, and discussions. Compared to direct teaching, all of these activities appear to require more class time. They noted, however, that in most implementations of education reform, there is no concomitant increase in class time. These authors developed the curriculum materials of the Connected Mathematics Project (CMP) to complement the reform curriculum, but noted that they

> became concerned when teachers took much longer than anticipated to teach draft units of the curriculum. Furthermore, time was consistently mentioned as the primary concern when teachers were asked what difficulties they were experiencing in adapting to the CMP. (pp. 23–24)

Black (2004) was similarly interested in factors that influence or impede the implementation of mathematics classroom reform in the United Kingdom. Based on the recommendations of the education authority, mathematics instruction is to emphasise "interactive whole-class teaching" where "pupils are expected to play an active part by answering questions, contributing points to discussions, and explaining and demonstrating their methods and solutions to others in the class" (DfES, cited in Black 2004, p. 271). In her study, Black used an ethnographic approach to observe actual teaching (video-recorded), followed by interviews with teachers to examine the instructional issues involved in carrying out "interactive whole-class teaching." Through analysis of videos and the interviews, she found that time pressure played a significant role in the teachers' decisions in class. For example, time pressure restricted the extent to which teachers probed the understanding of students who were not able to give a productive response immediately during whole-class discussions. Black (2004) concluded that the

> [l]ack of time forced the teacher to progress quickly with the curriculum in order to cover all areas; this meant that she had to maintain control over discussions which took place. … It appeared that she was under pressure to get through the discussion as quickly as possible so that the children could get on with their individual textbook work. (p. 356)

She inferred that such findings highlighted challenges associated with "interactive whole-class teaching."

Time plays an important role too in efforts to integrate technology in the classroom. Assude's (2005) research involved the integration of *Cabri* software in two classrooms over a 2-year period in France. Assude found that the teachers constantly grappled with the issue of time limitations throughout their attempts to weave *Cabri* into their teaching of geometry. In the first year, the teachers were less familiar with the software and with how to mix productively students' work with computers and work with paper-and-pencil. Moreover, teachers were not able to anticipate well how students would take to a changed mode of instruction: how long they take to be sufficiently proficient with the software and how well they can use the software to learn geometry. These uncertainties impacted on teachers' decisions about how much time was needed for certain planned classroom activities. It resulted in situations where some activities actually took longer than expected or were not time-efficient in helping students learn the required geometrical content. In the second year of the study, the teachers were able to devise some time-saving strategies that they felt partially alleviated the problem of content coverage with *Cabri* given limited time. Despite the investment of a 2-year period of research to understand the time-related issues, however, there appeared to be no easy answers because of the complexity of the problem. This facet of mathematics teaching is one that deserves further investigation.

It is easy for those outside the teaching community to dismiss teachers' claims of time pressures merely as excuses for lack of effort in improving practice. The literature reviewed above presents a different picture: Real time pressures that teachers face on a daily basis in their classrooms are significant obstacles to innovative practices and can hinder effective teaching. It is thus important to take into account teachers' experience of time pressures in studies about improving classroom practice. Apart from acknowledging the strong influence of time pressures in affecting instruction, more research is needed about the nature of time pressures that teachers face in actual practice. In particular, there should be close study of the problems they cause and the ways teachers cope with them.

The study reported here examines how the goal to keep to time in the classroom affects the whole teaching enterprise. The focus is not merely on those moments when time pressure was felt intensely and accounting for how they occur; neither is the inquiry only about specific time-saving measures to counter the lack of time. The approach taken is one that views time-related problems and coping strategies against the complex context of other worthy but competing goals of actual practice.

A goal-based approach to the problems of teaching

Teachers' actions in classrooms are driven by their conscious and unconscious goals for their teaching. The Teacher Model Group at Berkeley, led by Alan Schoenfeld, developed a goal-based methodology to analyse teaching (Schoenfeld 2000). A significant number of projects and reports from this Teacher Model Group were based on this approach to analysing teaching (Aguirre and Speer 2000; Sherin et al. 2000; Schoenfeld et al. 2000; Zimmerlin and Nelson 2000). There were a number of motivations behind the analytical model they developed. First, their model aimed to take into consideration the various interacting complexities inherent in the work of teaching. Schoenfeld (2000) noted that different educational research traditions tend to focus on different factors that influence teaching—for example, some on "content," and others on "human factors." It was asserted that the model, "via the creation of a goal-driven architecture … did equal justice to both the content-related and the human factors aspects of [teaching] interactions" (p. 246).

A key assumption behind the goal-based approach is that every teaching action is motivated by one or more teaching goals. This allows an analysis of teaching not merely at the level of observable actions but also at the level of underlying intentions of the teacher when those actions were carried out. In other words, in analysing the work of teaching, the goal-based method places implicit importance on both the observable acts of the teacher as well as the unobservable ones—such as the thought processes of the teacher in classroom decision making.

Interpreted through this goal-based framework, the motivation to complete the teaching of a planned component within an allocated time is seen as a goal of teaching. In the context of classroom instructional practice, this is but one of many goals of teaching. Other goals of mathematics teaching might include the goal of teaching mathematical language, the goal of teaching mathematical reasoning, the goal of helping students correct their errors, and the goal of instilling positive attitudes toward mathematics learning, among many others. That teaching involves complex and, at times, problematic interactions among such goals is illuminated by the work of Lampert (1985, 2001). Using language consistent with the goal-based methodology, we define a "problem of teaching" as a situation in which the successful carrying out of one or more goals of teaching is hindered. "Coping strategies" are then the mechanisms used by the teacher to advance, perhaps only partially, some or preferably all of the goals of teaching despite the constraints posed by the problem. This puts goals at the centre of many teaching dilemmas: Teachers' work is to fulfil their teaching goals and thus circumstances that interfere with this are problematic and need to be managed.

In this paper, we look specifically at problems of teaching that involve the goal of keeping to time. In examining time-related problems and ways to cope with them, we account for the complexity of actual teaching by studying the interactions between the time-keeping goal and other goals of teaching.

Setting and method

The research reported here was part of a project to investigate the problems of teaching geometry in a naturalistic classroom context. The duration of the study covered an introductory geometry module of 11 lessons, each of 70 min. The class chosen for the study was a Year 7 Singapore class of average mathematical ability. During that period, the first author—henceforth referred to in the first person—replaced the resident teacher to assume the role of the class's mathematics teacher. In this role I was both teacher and researcher. Previously, I had spent the first 7 years of my professional career teaching mathematics in school settings ranging from Year 7 to Year 12 prior to a university career in teacher education and research. This background helps to clarify my experience, expertise, and awareness in both teaching and research.

The use of the teacher-researcher enterprise is a deliberate attempt to tap directly into the "craft knowledge" (Leinhardt 1990) that teachers employ to carry out their classroom practice. Practitioner knowledge can complement traditional research knowledge in that it is linked with practice. Unlike traditional research that organises knowledge according to types, "in practitioner knowledge, all these types of knowledge [referring to content knowledge, pedagogical knowledge, and pedagogical content knowledge] are intertwined, organized … according to the *problem* the knowledge is intended to address" (Hiebert et al. 2002, p. 6, emphasis added).

One can, of course, argue that researchers can access practitioner's knowledge without themselves being the practitioner. That is, they could collect data from teaching practice via conventional methods as an outsider, not as an insider. It is likely that an outside researcher looking at the same data might view instructional interactions differently and can therefore offer an outsider perspective of classroom phenomena. The author shares Kemmis's (1995) stance in valuing studies of practice both "from the 'outside' and from 'within' the individual and social relations of the group" (p. 24).

However, it is doubtful if the kind of information gathered from the outside would be as "experience-near" (Geertz 1983) as those obtained from insider's accounts. Many of the problems of teaching practice reside not only in externally observable teaching acts, but also in the teacher's thought-world. The internally unobservable problems include managing dilemmas (Lampert 1985) and coping with conflicting goals of teaching—what teachers called "walking the pedagogical tightrope" (Wood et al. 1995) or balancing of goals (Leong and Chick 2007/8). The thought reflections of the teacher, which contribute substantially to understanding teaching practice, would be unlikely to surface if a similar inquiry is done by an outside ethnographer. Anderson (2002) argued that "for practitioners, who act daily in the setting …, [their] knowledge [of the practice] is deeper, more nuanced, and more visceral" (p. 23).

My teaching actions and thoughts were captured via in-class video and post-class same-day reflections. The reflections were made while reviewing the teaching actions in the lesson from the video-recording, noting my account of the thoughts and decision processes I had undertaken at various stages of the lesson. The transcribed video of lessons formed the primary source of analysis. The textual form of the video data, the pre-lesson written plans, and the post-lesson reflections (transcribed from audio form into text) were coded based on the goals identified (elaborated later). Analyses of the data proceeded along two main phases: the detailed initial analyses using these data sources on one lesson, yielding some conjectures about emerging themes; followed by the testing of these conjectures through the broader analyses of other lessons in the module.

In examining teaching practice, it is generally agreed among researchers that it must be parsed into units of analysis so that teaching can be studied. The literature on classroom research indicates that the size of the unit of analysis varies greatly. It can be as "small" as a few words or as "big" as a whole-year teaching programme. Schoenfeld et al. (2000) chose the predominant unit of analysis as an utterance—"[t] he analysis, often carried out on a line-by-line level …" (p. 281)—in their study of a classroom lesson. Hiebert et al. (2002), in contrast, suggested that to accumulate a knowledge base of teachers' craft knowledge, "one possible unit of analysis is a natural one for teachers—daily lessons" (p. 8).

Lampert (2001) proposed that units of analysis can be of flexible sizes to suit the different purposes of inquiry. She suggested that the decision on the "frame size" for analysis should be based on "workable representations" that appropriately capture the complexity of the teaching practice. By that she meant that the unit of analysis should be one that "could achieve the purpose of representing the complexities of teaching for productive communication about the *problems* of practice" (p. 43, emphasis added).

We share Lampert's (2001) view of the use of adjustable frame sizes to capture the complexities of teaching in order to study problems of practice. The method of analysis used in the project incorporated this use of flexible frame size to examine teaching practice, with frame size depending on the details required. It can be an at-the-moment frame to zoom in on a specific problem faced by a particular student, or a wider frame zoomed out over a temporal range of a few lessons to look at the students' class work over a period of time. To locate these suitable frames of analysis from the data, we looked for moments in my teaching where internal tensions in carrying out intended instructional goals were experienced. We termed these tension points "triggers" to problems of practice. These triggers preceded or were virtually simultaneous with problems, since the situations evoking the tensions may develop into cases where one or more teaching goals can no longer satisfactorily be achieved.

In this paper, since the focus is on time-related problems experienced in teaching, a workable unit of analysis chosen is one where triggers associated with the shortage of time were most frequently and intensely experienced. As the method of analysis requires in-depth examination and presentation of goal interactions, only one unit of analysis—surrounding Lesson 4 of the module—will be discussed in detail. As will be exemplified in the next section, to account for the complexities surrounding time pressures experienced in actual teaching, the analysis included temporal regions prior to the lesson. Insofar as the time pressures encountered in and around Lesson 4 illustrate and are indicative of the kinds of time-related problems experienced throughout other lessons in the module, this analysis can be regarded as an exemplary case study (Bryman 2004).

In keeping with the goal-based approach, the relevant teaching goals applicable to Lesson 4 are explicated in Table 1. These goals were identified by examining the transcriptions of the video recordings of classroom instruction and the post-lesson reflections. These goals were not spelt out in advance of instructional events; rather, after studying my teaching plans, actions, and reflections, I determined the underlying goals that drove my instructional behaviour. I did not arrive at all the goals in *one* attempt at examining the data. I started by coding the first lesson of the module with broad goal categories. As I proceeded in the coding process from lesson to lesson, I modified the goals gradually through a process of repeated refinement—by adding new goals that I recognised as accounting for practices as I viewed more data, and by collapsing and rephrasing some goals to capture a wider spectrum of actions.

Table 1 List of my instructional goals for teaching Lesson 4

gtim	To complete the teaching of a planned component within the time I allocated for it
gcov	To cover the geometry topics as stipulated in the school's schedule
gerr	To highlight students' (potential) errors and to correct them
gart	To encourage students to articulate their observations, conjectures, refutations, justifications, results, and explanations
gmea	To teach the geometric meanings and relationships underlying accepted facts or solutions to problems
gsol	To teach students the solution(s) to textbook or worksheet problems
grea	To teach students to reason deductively about geometrical ideas

The first letter labelling of "g" reflects the representation of "goals" and the following three-letter labelling of the g-goals abbreviates the summary of the goal. The goal *gtim* is italicised and listed first as it is the central goal under examination in this study. The remaining goals in Table 1 are merely a subset of the complete set of goals I have in teaching. The complete set of goals are, in fact, simply more detailed subgoals of broader goals I had for the entire module (see also Leong 2008).

The presentation of these teaching goals in a list is not to suggest any order of priority. More significantly, we do not suggest that they are easily separable when observing actual teaching behaviour. In practice, classroom events may fulfil one or more goals. Also, the goals may not be independent of one another, since the fulfilment of one may support or hinder the fulfilment of others. It is the latter circumstance that creates a problem situation. The interaction between goals during practice is a complex one and the delineation of my teaching goals in point form is partly for ease of reference.

It is useful to clarify that the goals of teaching listed above are *mine*. This personal ownership of goals is not to deny the fact that they are influenced by the social and cultural emphasis of broader mathematics education goals in Singapore. Indeed, some of the goals in Table 1 may also appear as goals in curricular documents of different jurisdictions. Rather, the stating of the goals being *mine* is to highlight the personal agency in mediating these broader goals into the actual goals I bring into the classroom. When I enter the classroom, these teaching goals accompany me and influence my classroom practice because they have become intertwined and inseparable from the belief and knowledge system within me. They are rightly termed as *my* teaching agenda because they show my perspective and interpretation of the teaching task.

This set of goals may not be held by other teachers in the same way nor in its entirety. Nevertheless, it is heartening to know that some of my teaching goals are shared by other teachers, even though the cultural setting in which we operate may be different. For example, that the goal of keeping to time in teaching [*gtim*] is valued across geographical boundaries was already highlighted in an earlier section. In Wiske's (1995) project, which involved collaborative work with teachers, he reported that "teachers defined the [instructional situation] in terms of the types of problems, taken from their texts, tests, and workbooks …" (p. 193). This focus on curriculum documents seems to strike a close match to gsol above. Regarding gart, gmea, and grea, there is ongoing interest in the wider research community on these aspects of teaching. Thus, although the teaching agenda that I bring into this study is indeed my own in the sense that it is conceived and implemented by me as the teacher, there is an added sense that at least some of the teaching goals are shared with and can be appreciated by a wider group of teachers and researchers. Moreover, the goal-based approach used in this study provides a useful methodological lens to view the actual problems of teaching via the complex interactions of underlying instructional goals.

Examining time pressure

Build up of time pressure *before* the lesson

As a background to what was expected to be taught in Lesson 4, part of the module plan is reproduced in Table 2 for the reader's reference. In preparing the module plan

Table 2 Extract of module plan referring to Lesson 4

Lesson number	Content coverage/progression	Textbook exercises
4	(i) Use the "Menu" function [of the *Geometer's Sketchpad*] to measure angles—interior angles of a triangle. (ii) Lead to "sum of interior angles of triangle is 180°"; "exterior angles of a triangle add up to 360°"; and "an exterior angle of a triangle is the sum of the interior opposite angles." (iii) Lead to an explanation of the results.	14A: Items 9–12

in advance of teaching the 11-lesson sequence, my structure and schedule for the whole module is outlined.

From the syllabus-coverage point of view, a purpose of the module plan was to partition the geometry content into achievable lesson-size bits so that I, as the teacher, could compare the actual coverage in my teaching against the module plan from time to time and moderate my pace accordingly. Up to Lesson 3, the content dealt with in my in-class instructional work matched closely the coverage spelt out in the module plan.

The three main goals of the lesson, as expressed in my original module plan, were to help students observe and conjecture angle properties related to triangles [gart], to teach the underlying geometrical explanations of these properties [gmea], and to deal with solutions to some related textbook-type problems [gsol]. Prior to actually teaching Lesson 4, however, I needed to add[1] to what was in the original module plan. At the end of Lesson 3 I had collected students' homework assignments. While marking them I detected some common errors. In the spirit of giving timely feedback, I intended to include a discussion of these errors in Lesson 4. I thus modified the goals-mix in Lesson 4 by adding the goal of correcting students' errors [gerr]. The inclusion of gerr was reflected in Component I of the lesson memo I wrote just before Lesson 4 (Table 3).

The introduction of gerr, however, changed the goals-combination of the lesson in a way that triggered a tension among the goals for me. Since the duration of a lesson was fixed, adding another component to the lesson—in this case Component I—naturally reduced the time for other components (II–IV). In my perception this would hinder the achievement of some of my original goals for the lesson, thus creating a problem. As I saw it, there were only two courses of action, or coping strategies. The first was to reduce the depth of coverage of the original components to make time for Component I. That course would advance goal *gtim*—to complete the teaching of the planned components within the required time. However, it was

[1] *Post hoc* analysis of my decision-making processes at various junctures of the lesson may reveal interesting alternatives based on different conceptions of the teaching-learning dynamic. However, this study is about analysing teaching goals that are carried out in the moment-by-moment improvisations of actual practice. A discussion on alternative ways to carry out these goals is thus beyond the scope of this study.

Table 3 Notes on Lesson 4 just before the lesson

I.	Revision of homework problems
II.	*Geometers' Sketchpad* work on angles of triangles
III.	Conjecturing of properties in the whole-class discussion
IV.	Textbook exercises

problematic as it would lead to compromises for the intended goals in the other lesson components. In this sense, introducing gerr into the pool of goals would have *diluted* the prominence of the remaining goals (other than gtim) in the lesson. The alternative course was to retain the pace of coverage but "push" one of the components to the next lesson. In my mind, though, I knew this might simply postpone the problem, with accumulating uncovered content. That, however, would have violated gcov—the goal of covering all geometry topics as given in the schedule. A diagrammatic summary of the problematic situation is shown in Fig. 1: Either path attempts to cope with the problem of the original goals being affected detrimentally.

My decision was to take the "incorporate all" route, and the details of my lesson memo reveal some anticipated dilution in the coverage of the other components of the lesson. The most obvious reduction was in Component III of the lesson. I had originally wanted to cover three theorems about angles in triangles, but my plan revealed that I "will select one or two [angle properties of triangle] to explain." Despite that improvisation to cut down on the number of properties to discuss, I was still concerned about having enough time. The continuing time pressures I felt during the lesson are discussed in the next section.

Time pressures experienced *during* the lesson

As planned, I started the lesson with a whole-class discussion of the homework assignments. For this, I selected the two homework items that had been the most poorly done. For the first exercise, I presented a sequence of incorrect solution

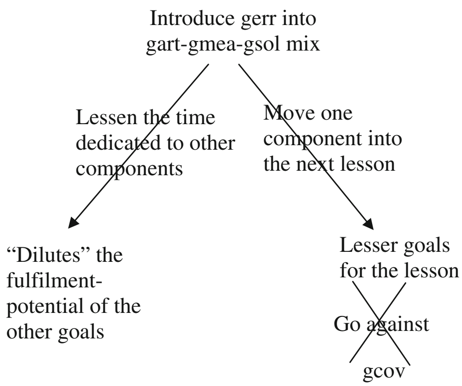

Fig. 1 Consideration of instructional courses before Lesson 4

strategies to highlight the kind of errors students had made in their homework submissions. I invited students to evaluate those approaches. After I explained the errors, I moved on to discuss the alternative correct solutions. I completed the discussion of the first exercise by writing out the detailed solution steps with the help of students voicing the steps. My approach here was intended to allow fulfillment of not just gerr, but also goals gart and gmea.

I then asked for suggestions on ways to tackle the next problem. At that point I looked up at the clock and realised that more than 20 min of the lesson time had gone by. My post-lesson reflections reveal the problem associated with time pressure:

> I was moving along [to] the second question and I glanced at the time and immediately felt the time pressure … . [B]ecause of the time pressure, I chose to go directly at presenting one of the correct solutions given by one of the students.

Normally, I would have asked the students to evaluate the errors [gerr], to articulate their methods [gart], and possibly to explore alternatives [galt], as was done for the first question. However, due to the "time pressure" trigger, I chose to directly use one student's correct approach and presented the working steps that followed from that solution path. I had to "sacrifice" the ideals of gerr, gart, and galt in the discussion process to the more immediate goal of *gtim*—to complete the teaching of all the planned components within the lesson time.

The second awareness of time pressure occurred during Component II when I was demonstrating some features of *Sketchpad* that students would be using. I was midway through a demonstration when the first bell rang, indicating the halfway mark of the lesson, and again triggering tension. However, because of the need to carry out the remaining planned components of the lesson, I had to "cut short" the time on the computer exploration of angles by limiting it to only 20 min:

> 29.52 T: I'm only giving you 20 min to do that. You are doing "Angles of triangle" [clicks and opens the *Sketchpad* file to show the template], so you'll be doing this one later on. And there are two worksheets for you [points at the documents using the cursor]. You are given 20 min to do it—Go! [Students speed off immediately to their computer terminals]

Twenty-one minutes later, the students were back in their seats for the next section of the lesson. As planned, Component III was about getting students to conjecture angle properties of triangles based on what they noticed in the computer exploration. I invited students to state their observations, in keeping with gart. To encourage their contributions, I wrote their conjectures on the left of the board. The students were forthcoming and soon listed relevant observations that could be extended to properties like "exterior angles add up to 360°," "exterior angle equals sum of interior opposite angles," and "interior angles add up to 180°." In fact, student Xiao was keen to continue the conjecturing process but I stopped him in order to get on with the next part of the lesson. The desire to keep to time and to complete the planned teaching [*gtim*] was again stronger than the motivation to encourage students to voice their conjectures [gart].

According to the lesson memo, I was to "select one or two" of the conjectures on the board to discuss the underlying geometrical reasons for why they were true [gmea] as well as to show the proofs of those stated results—as a way to teach deductive reasoning [grea]. The three key theorems are listed in Table 2.

As mentioned earlier, the "one or two" was already a reduction from the "three" targeted theorems in the module plan. With very limited time remaining in the lesson, I had to make a further reduction, to only one theorem. This was problematic in that it was a further dilution of the original goals of gmea and grea.

My choice at that point was the second theorem. The preference for the second over the third was motivated by curriculum coverage [gcov]. The second was preferred over the first as aspects of the latter had already been taught at the primary levels of schooling. The third theorem would be formally introduced in the Year 8 syllabus whereas the second was required immediately.

The final trigger of time pressure came when the second bell rang—signalling the end of lesson time. I was still only halfway into explaining the overall proof strategy of the second theorem using a diagram on the board, reproduced in Fig. 2.

As I was reluctant to stop at this unnatural juncture, I pressed on to complete the proof explanation by writing down the steps of the proof:

$$a + b = 180$$
$$b + c + d = 180$$
$$a + b = b + c + d$$
$$a = c + d$$

However, with time already up, I had to present this in an unusually quick manner, wondering later in my reflections if the students "got it." This hasty proof explanation was another interference to the fulfilment of grea.

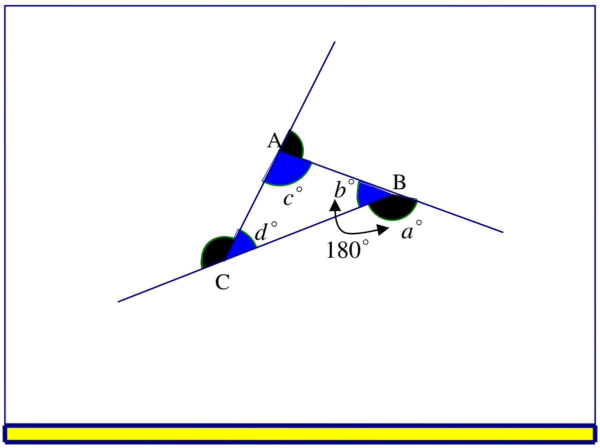

Fig. 2 Diagram on the board when the second bell rang

Ironically, despite sensing the need to speed up at many points in the lesson—and doing something in response—I had to end the lesson with a large chunk—Component IV—not done. This component comprised textbook exercises. While the primary intent behind Component IV was gsol, the premature end of the lesson meant that this goal was completely abandoned.

Discussion

When viewed solely as a narrative of instructional sequence, the above account can appear as a typical anecdote of "Not enough time." In contrast, when the instructional decisions were examined as arising from interactions between competing goals, the tensions experienced by the teacher in relation to time pressure can be seen as part of a deeper complexity of coping with multiple goals of teaching. Also, these tensions did not occur in isolation; rather, how they arose can be accounted for against the context of goal interactions and triggers.

Looking back, it was clear that there were triggers that led to the situations of internal tension. The various triggers were largely associated with time pressures and they seemed to form a linked chain. Consecutive awareness of each temporal tension seemed to heighten the sense of the importance of keeping to time and thus "keep things short." That tendency culminated at the end of the lesson where the last bell triggered the urge to wrap up the lesson quickly. Figure 3 illustrates the linkages between the triggers and the increasing time pressure as the lesson drew closer to the end. The bold peaks in the figure (referred to as "problem peaks") represent moments when the problems of having to deal with time constraints were felt most acutely, and where goals consequently were compromised.

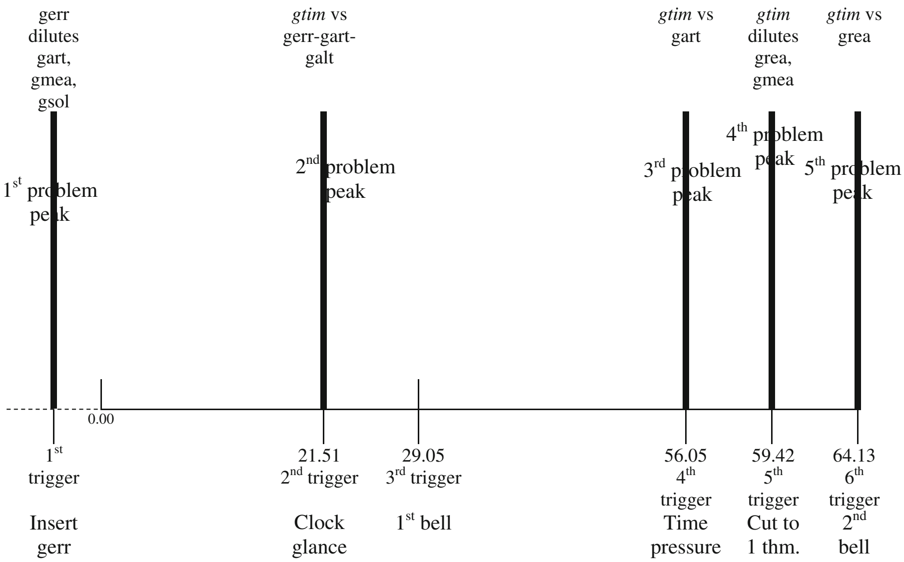

Fig. 3 Temporal region involving time pressures

Similar patterns involving *gtim* over a range of temporal grain-sizes (analysed through frames of different sizes) were found throughout the module. Problems occurred when I could not fit all the intended goals into the available time. Apart from Lesson 4, problems involving time were prominent also in Lessons 2, 7, 8, and 10, in each case yielding goal mixes and problem patterns that are similar to those shown in Tables 1 and 3 respectively. For example, in Lesson 2, the analysis involved a much shorter temporal region of less than a minute but shows how the desire to advance a productive classroom discussion was hindered by a consideration of simultaneous goals, including gart, gcov, gmea, and *gtim*. In each of these situations, the emergence of *gtim* was keenly felt and it played a critical part in the subsequent instructional choices I made.

It is interesting to note that phenomena which can have direct impact on time consciousness during the lesson can actually occur *outside* the classroom. In the case of the lesson under discussion, the start of the whole string of time pressure triggers took place even *before* the lesson, when I decided to insert a new component of “homework revision” into the teaching plan. As was seen in the account described above, that introduction of an additional lesson component accentuated the pressure of having to cover more content with no concomitant increase of lesson time, leading to increased time pressure with each awareness of being behind schedule during the lesson.

One way to approach the alleviation of in-class time pressure for teachers can therefore be directed at out-of-class activities and decisions that can have heavy influence over instructional behaviour in class. This report highlighted how pre-lesson insertion of “homework revision” was one such candidate for increasing the time pressure during lesson time. Other possible candidates may include class tests, administrative tasks, and lesson cancellations (which indeed occurred in Lesson 10 and acted as a trigger to other ensuing problems of teaching), which are not uncommon occurrences in schools. School teaching schedules usually only list the mathematical topics to be covered and do not usually set aside time for these necessary or unavoidable changes to the original instructional plan. Like the inclusion of homework revision in an already packed teaching schedule, the perturbations from these sources can significantly heighten the tension of time limitations in class.

The lesson analysis also points to time pressure as a key determinant in deciding instructional courses in class. In each of the five points of the lesson where time pressure was felt (Fig. 3), it resulted in some changes from the original teaching plan. In the first instance, I chose a direct approach to showing the solution of the second homework question instead of drawing upon students’ participation; in the second juncture, I restricted students’ computer work to 20 min despite intending them to have more time; in the third trigger, I interrupted student Xiao even though I saw the educative benefits of getting students to make conjectures; in the fourth occurrence of time pressure, I reduced the number of theorems to only one; and in the fifth instance, coinciding with the final bell, I rushed to complete the written proof. These improvisations, made with each peaking of time pressure, indicate that the goal to cover content while keeping to time is a strong enough motivation to effect changes to the instructional paths in class. Time pressures are therefore not insignificant occurrences to be quickly dismissed as peripheral to teachers’ instructional life. On the contrary, they may be intimately related to instructional decisions, both affecting and being affected by them. This implies that efforts to help teachers improve the quality of teaching in class should take into account temporal considerations.

The goal of keeping to time also does not occur in isolation but interacts with the other contextually dependent goals of teaching that often emerge at the same time. At one point, I was deciding between including the "homework revision" component or moving other displaced components to the next lesson, while considering the implications of each choice with respect to syllabus coverage; at another juncture, I needed to prioritise between keeping to time and continuing to engage students in worthwhile discussions. These moment-by-moment spontaneous decisions that teachers make in class in relation to time use are influenced by the changing flux of instructional goals in the minds of teachers when trying to carry out instruction with limited time. In helping teachers cope with the stresses of time pressures in the classroom, there is thus a need for greater understanding of how their instructional goals are developed and how these goals interact with one another within limited time frames.

The way I coped with these time-related problems involved an ongoing monitoring of changes in the instructional situation. The changes were made evident by the presence of triggers and arose because of the different sets of goals in consideration as a result of my attending to these triggers. The fact that these changes were noted and acted upon showed that I was first of all aware of the existence and influence of these elements in the classroom setting. Awareness precedes action or decision. Whether it was cognizance of the first trigger involving a wider set of goals, or the consciousness of limited time after the first bell, these examples showed my awareness of the changes as part of my way to cope with the related problems of teaching. In addition, the monitoring was not a one-off event. Rather, as seen from the various changes of goal combinations within (and before) the lesson, there was an ongoing update of the changing situations in response to the dynamic goal-interaction situations throughout that period.

Coping with time pressures also involved tapping into internal resources, such as my own pedagogical content knowledge. In the process of weighing possible instructional tracks at different problematic peaks, I used my knowledge of possible teaching options to make ongoing changes in the instructional situation. This is best illustrated by Fig. 1, which depicts how I was able to weigh the options and consequences of each choice; this approach featured prominently among my coping strategies. Similarly, in choosing to consider the second theorem, I was drawing on my knowledge of the syllabus and broader mathematics curriculum. In cases where problems consisted of conflicts between different goals of teaching, coping necessarily involved prioritisation of goals at each of those junctures.

Conclusion

Herbst (2008, p. 126) writes that as part of the didactical contract teachers are "*entitled* to decide what will be done [in the classroom]" and are also "*accountable* for that work." Later, he writes that "Accountability and management are *not necessarily conscious* problems for a practitioner, so one might not be able to elicit them as declarations of belief or goals" (p. 127), yet this study has highlighted that accountability and management can come to the fore of teachers' consciousness and, moreover, that this awareness is intrinsically linked to a teacher's goals. The use of the goal-based methodology in this study highlights the goal to keep to time in teaching as not an isolated motivation; rather, it is one of many competing and interacting goals that are being considered as a teacher weighs instructional choices. Seen against the context of triggers that led to internal tensions, problems of time pressures can be viewed not as stand-alone peaks but as parts of a linked chain of goal considerations along a wider temporal region.

This study further supports teachers' claims of having "too much to teach with too little time": Time pressure is a real day-to-day classroom experience. Teachers have multiple goals to fulfil in their instructional work which include syllabus coverage, helping students learn the deeper meanings of the content, teaching mathematical reasoning, and encouraging students to participate in discourse about mathematics. In addition, there is the added constraint of having to achieve all these within limited time. A constant sense of time pressure in teaching can be problematic because it can result in instructional compromises. Worthy goals of teaching can be relegated to lower priority because there is no easy way to fit all of the emergent goals into a lesson and yet keep to time.

Teachers' sense of time pressure should also not be seen merely as an isolated experience disconnected from other aspects of the teaching practice. Rather, time-related tensions are often intertwined with other competing goals of teaching. Thus, attempts to understand teachers' struggle with time constraints should take into consideration this complexity of interacting goals and the challenges within the teacher's thought-world of prioritising goals as well as weighing instructional options.

There is also evidence in this study to substantiate the claims of the earlier-reviewed literature that time constraints can act as significant obstacles to reform-oriented teaching. Seen through the goal-based framework, increased demands brought about by reform—such as technology integration (Assude 2005), students' active participation (Keiser and Lambdin 1996), or engaged discussions (Black 2004)—translate into more goals for classroom instruction. These are worthy goals of teaching and the realising of these ideals is the object of many 21st-century teaching models. However, the transfer of intended instructional goals into the classroom is by no means a straightforward enterprise. Recognising the reality of time constraints and the problems it can cause, there is perhaps an urgent need to move away from simply *adding* more demands to the instructional work of teachers; rather, the priority is in the successful *integration* of instructional goals amidst the inherent complexity of the teaching practice.

In this paper, we argue that a critical part of teachers' practice requires goal balancing in order to keep to time amidst other demands of teaching. The amount of research and teacher education development work devoted to this part of teachers' practice have so far been relatively scarce. It is hoped that the study here will raise awareness and prompt further research in this direction.

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