Chinese Students’ Engagement with Mathematics Learning

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Abstract
Over the past decade it has been frequently reported that East Asian students are outperforming their Western counterparts in international tests of mathematics at middle-school level. This paper probes classroom discourse in an attempt to shed some light on this phenomenon. Data were collected from a sample of Chinese Year 8 students in a normal school in the city of Wenzhou China in 2012. The data focused on the students’ academic engagement in the study of mathematics, both at school and outside school. Data were collected via surveys, student sketches, open-ended written comments, classroom observations and commentary by teachers. The data were interpreted through a theoretical lens described by Basil Bernstein and extended in empirical work in Australia by Parlo Singh. It was found that pedagogic discourse in these Chinese classrooms was strongly shaped by consensual and differentiating rituals that buttressed a broader cultural respect for valuing esoteric forms of mathematics. In the main, the students in this study were highly engaged and satisfied studying abstract mathematics in teacher-centred classrooms. The findings have implications in regard to the assumptions underpinning much of current Western curricular thinking about engaging middle-school students in the study of mathematics.

Key Words: Mathematical discourse; curriculum; China.

Introduction
In this paper we document the level of academic engagement of Chinese students in Year 8 and provide a detailed description of this engagement in terms of homework commitment and classroom engagement, as well as describe their motivations and feelings about studying mathematics and what they perceive to be challenges to their study of mathematics. This rich description is set against cultural expectations and curriculum reform in China and the West. In part, we are motivated to explain why Chinese students appear to do so well in international tests of mathematics generally. For example, Trends in Mathematics and Science Study (TIMSS) (Thomson, Wernert, Underwood, & Nicholas, 2007; Thomson, Hillman, Werent, Schmid, & Munene, 2012) illustrate that East Asian nations (Singapore, South Korea, Hong Kong, Chinese Taipei) tend to have a much higher proportion of students in top bands, as well as generally lower spreads across bands, compared to Western nations such as the US, UK and Australia. The differences reported by Thomson et al. (2007; 2012) have been consistently noted in large-scale international surveys over several decades (e.g., Fan & Zhu, 2004; Jensen, 2012; Zhao & M. Singh, 2010) involving a range of testing instruments (e.g., TIMSS, Educational Testing Service (ETS), International Assessment and Educational Progress (IAEP) and Organization for Economic Cooperation and Development (OECD) tests, as well as Programme for International Student Assessment (PISA)). It has been reported that East Asian nations
have implemented curriculum reforms that have resulted in improved levels of achievement over the past decade (Jensen, 2012), and that at the same time there has been an increase in equity in these nations. Some number of studies noted that Chinese students did not perform at such high average levels on more challenging tasks, such as open-ended problems (e.g., Fan & Zhu, 2004). However, Chinese students—whether they be from Mainland China, Hong Kong, or Taiwan, or whether they are ethnic Chinese students in Singapore—tend to outperform students from other ethnic or cultural groups on standardised tests of mathematics. Researchers have explored possible reasons for Chinese students’ superior performance in many aspects of mathematics. The consensus from most authors is that a range of variables interacts to promote high achievement, and these variables include societal expectations, parental involvement, text books and academic learning time (Jensen, 2012; Fan & Zhu, 2004; Zhao & M. Singh, 2010), as well as teacher knowledge and pedagogy (Ma, 1999; Li, 2004a; Zhang, Li, & Tang, 2004; Gu, Huang, & Martion, 2004; An, 2004; Wang & Murphy, 2004).

Our focus here is on the intended and enacted curriculum. We look at curriculum reform, in particular forms of mathematical knowledge, using a framework based on the work of Basil Bernstein (2000; 1996), Johan Muller (2000), and Parlo Singh (2001; 2002; 2013a,b,c) and examine how the intended curriculum is filtered through the cultural practices and beliefs and how these manifest in classroom discourse. In exploring classroom discourse we draw on the work of Bernstein (1990; 1977; 1975) to help make meaning of students’ goals and beliefs, an important measurable indicator being academic engagement. The primary source of data is Year 8 students’ reports on their out-of-school commitment, how hard they work in classes, what motivates them to act as they do in mathematics classrooms, and how they feel about the learning processes. Students’ beliefs and goals are likely to be reflected in their commitment to mathematics study, thus a measurable outcome of student beliefs is their reporting of how hard they work in class and the extent of their homework commitment. East Asia and China in particular have different academic traditions, thus the study examines learning assumptions in East and West. Since the first author is Australian, he views Chinese subjects from a Western perspective. These ways of viewing mathematics and learning are explored below.

Forms of knowledge: Everyday and school knowledge in the East and West

Various terms are used to describe different knowledge forms and in particular views of the nature of mathematics. Frequently authors describe polar views of the nature of mathematics. For example Ernest (1996; 1997) described absolutist and fallibilist ways of viewing mathematics. Absolutist views of mathematics were linked to objectivity, certainty and deductive logic. In contrast, fallibilist views were linked to seeing mathematics as the outcome of social processes and open to revision. Similarly, Bernstein (1996; 2000) used the terms common/mundane/everyday to refer to meanings that arise out of direct encounters with the real world. This has been described as “horizontal discourses” (Singh, 2002, p. 574) since the knowledge grows out of the community; boundaries between schools and the community are highly porous, promoting a two-way transfer of knowledge. Mundane or everyday knowledge is acquired through everyday activities in a segmental fashion and is not logically, coherently or cumulatively connected. Moreover, a special or privileged status is not conferred on this knowledge, or on those who acquire this knowledge, because it is usually accessible to everyone, and does not require specialist teachers/instructors to assist with the acquisition process. In contrast, esoteric/sacred knowledge is vertical in nature and is strongly associated with disciplinary knowledge constituted in scientific research communities, libraries and artistic organisations. Klein (2007) used the term “progressive” in a similar way that Ernest (1996) used fallibility and Bernstein used mundane or everyday to describe the relativist or horizontal views of mathematics, and “classical” to describe traditional views that are essentially vertical or esoteric in nature and, to a considerable degree, adhere to images that Ernest describe as absolutist. It is worth being mindful of these images of mathematics since it is well known that how the nature of mathematics is viewed has profound influences on how curricula are constructed and implemented (Ernest, 1997; Muller, 2000).
Bernstein (2000, 1996) has argued that, traditionally, school knowledge has been dominated by esoteric knowledge, and that the knowledge transmitted through schooling is a privileged form of esoteric knowledge which, when acquired, confers privilege on the acquirers. This distinction is especially important in fields such as mathematics where complex concepts are acquired gradually through a long process of socialization and induction into the language. Knowledge is cumulatively built through stages of progression, so that with advanced levels, students gain increasingly abstract concepts. Esoteric knowledge such as that traditionally taught in school mathematics curricula is rarely acquired without the assistance of teachers/instructors, who have a privileged position and tend to be regarded as experts.

At the school level, learning mathematics has traditionally focused on replicating what has been discovered historically in an attempt to duplicate the axioms of the discipline of mathematics, and it focuses on the degree to which students can reproduce the learning of prior thinkers. Discovery of new knowledge, and thereby production of new knowledge, is possible only after systematic induction into the discipline and only at the upper levels of the education system, namely, at postgraduate level. This perspective on school knowledge, a social realist perspective, leads logically to particular types of school curriculum and pedagogic modes, favouring pedagogies that focus on the performance of students on particular skills and knowledge, as well as processes of learning. Thus, the old and “traditional” mathematics curriculum and associated pedagogical approaches attempted to transmit disciplinary mathematical content knowledge processes and techniques, including algorithms and proofs. This curriculum and pedagogical approach had clear and distinct notions about what constituted school mathematical knowledge, such as the transmission of rules of arithmetic, geometry and algebra from the knower (teacher) to the learner (student); frequently this was associated with highly regulated classroom discourse with specific language related to the discipline of mathematics (Ernest, 1997; Muller, 2000). The implications of this view of learning are that the curricula tend to be highly structured and hierarchical, and the teacher has well-defined pedagogical roles to ensure the curriculum is enacted in a manner in which the integrity of the esoteric knowledge is maintained. The pedagogy associated with the attainment of esoteric knowledge forms limited the learner’s control over selection, sequence, or pace of learning, since the teacher had positional and authoritative control and regulated the pedagogy via explicit rules. This approach to teaching and learning is in marked contrast to relativist conceptions of knowledge, which view school mathematics, everyday mathematics, and work mathematics as different but equally valid and valued discourses or languages.

The relativist view of knowledge has, according to Muller (2000) and Hattie (2009), been strongly championed by the constructivist alliance. Supporters of constructivism have argued, consistent with the theorizing of Vygotsky (1987), that learners actively construct their own knowledge. Few debate this view; it is just that those who Klein (2007) says describe themselves as “progressive” have taken the theory of learning and used it as a justification for a theory of teaching, and named this “constructivism”. In applying this theory of learning in teaching situations, various practices have developed that encourage students to learn via investigation and enquiry, and through “authentic tasks.” This approach is based upon a horizontal view of the nature of the relationship between school mathematics and community mathematics. Thus the word “authentic” is frequently used by adherents of this view of mathematical knowledge and discourse: it is to be seen as directly linking to the out-of-school world of the learner. Further, such a view of knowledge has become associated with child-centred approaches to classroom discourse. In addition, horizontal knowledge forms have been increasingly linked to strong democratic underpinnings of classroom discourse where it was expected that students increasingly have control over selection, sequence and pace of learning with the teacher taking on the role of “facilitator” of learning (Muller, 2000). The argument is that if each child has to construct their own understandings, they will tend to do so in unique ways in their own timing; thus affording the learner greater control of the learning process is necessary. Muller (2000), Hattie (2009), and Kirschner, Sweller and Clark (2006) expressed the view that as a facilitator, the teacher was expected to relinquish the role of “knowledge expert” and share this role with students engaged in “discovering” mathematical concepts through a focus on the processes of enquiry. Thus,
constructivists concentrate their efforts on recontextualizing everyday knowledge into the curriculum. The principal assumption is that everyday (mundane) mathematics can be a bridge to learning school mathematics by means of teaching through everyday examples. An assumption frequently made is that that everyday mathematics is seen as relevant and authentic, connected to the immediate out-of-school lives of students, and as such is likely to be more intrinsically motivational to learners, especially disadvantaged learners. In short, it was anticipated that the authenticity of mathematical study would make it intrinsically appealing, and by actively constructing mathematical understanding, students would gain a deeper appreciation and understanding of the nature of mathematics. These assumptions are well documented in the rationale for recommended teaching practice in Western curriculum documents (Ernest, 1996; Klein, 2007) and teacher education handbooks (Norton, 2012).

**Western Curriculum Reform**

In the US, curriculum reform in the late 1980s found formalisation in the National Council for Teaching of Mathematics (NCTM, 1989) Curriculum and Evaluation Standards for School Mathematics, which set the basis for future reform curriculum documents. These documents not only stipulated what was to be taught, but contained pedagogical recommendations. There was an emphasis on students’ developing problem-solving skills by doing and engaging in mathematical activity. In the United Kingdom, in the Cockcroft Report (1982), there was an emphasis on “using and applying mathematics.” Reform curriculum documents also became concerned with student affect, as well as with an appreciation for the immediate utility of mathematics. For example, in Australia, the Australian National Statement on Mathematics for Australian Schools (Australian Educational Council, 1990) recommended that students’ feeling or affect be enhanced and that they develop mathematical capacity in problem solving and learn to use techniques that reflect modern mathematics (ICT and calculator usage) as well as to experience the process by which mathematics develops. Laborde (2002) summed up the French reform as a similar orientation towards experimenting, modelling, formulating, interdisciplinary projects, mastery of mathematical techniques and the use of information technology in learning mathematics. There is much similarity in regard to curriculum reform across Western education systems in which students have been expected to reinvent mathematics by engaging in “authentic” mathematical processes intended to be personally meaningful to the students. This revision agenda has not gone unchallenged: the “maths wars” in the USA (Klein, 2007) and more recently the Queensland Parliamentary inquiry into assessment methods for senior maths, chemistry and physics (Queensland Parliament, 2013), for example, are manifestations of debate in the nature of mathematics and its teaching and learning. Hattie (2009, p. 26) noted: “Constructivism is too often seen in terms of student-centred inquiry learning, problem-based learning and task-based learning.” He further commented that the enactment of such approaches is “almost directly opposite to the successful recipe for teaching and learning…” (p. 26). Kirschner et al. (2006) termed student-centred, inquiry-based learning “minimally guided instruction” and concluded that such approaches were “less effective and less efficient than instructional approaches that place a strong emphasis on guidance of student learning processes. The advantage of guidance begins to recede only when learners have sufficiently high prior knowledge to provide “internal” guidance” (p. 75). These comments sum up the arguments against a move away from valuing esoteric knowledge and the ways it has been traditionally taught.

**Far Eastern Curriculum Reform**

In the mathematics curricula of Far Eastern countries, including China, South Korea, Taipei, Singapore, and Japan, the content is arranged in strands or dimensions such as number and algebra, shape and space, statistics and probability and, in the case of China, practical and synthetic application. Thus, the content or substance of Far Eastern curricula is very similar to that of the West, the difference being that for East Asian students, a process of acceleration occurs where students, including Chinese students in Year 8, seem to be expected to be proficient in mathematics at a level that is not expected until Year 10 or later in the West. Thus, Asian and Western students essentially learn the same mathematics, and curriculum documents in all nations reflect critical words such as “generic skills” and “real life-related mathematics” to cultivate the interest of students and to blur the
boundary between school (esoteric mathematics) and the everyday mathematics of the community. Consistent with the principles of constructivism, mathematical understanding is recommended to be facilitated by discussion and investigation. At first view, the reforms to Eastern curricula indicate that their curricula is becoming westernized; however, the curricula are interpreted and enacted within a cultural context and, as we shall see in the following examination of Chinese cultural models of learning, these can have a profound influence on how curricula are enacted.

**Curriculum implementation**

Different cultural values impact on how mathematics is presented and learned. Various authors have reported that Confucian values about learning have profoundly influenced classroom discourse in the East for thousands of years (e.g., An, 2004; Lafayette De Mente, 2009; Lee, 1996; Huang & Leung, 2004; Jensen, 2012) and recent curriculum changes have had little impact upon this. Essentially, a very high value has been placed on formal learning and a great deal of effort is expected of children to gain perfection in the various disciplines. According to Confucian values, learning is intrinsically linked to virtue and higher moral and social obligation. Learning is thought to have four major purposes: (a) to attain moral perfection, (b) to acquire personal skills/knowledge, (c) to contribute to society, and (d) to obtain social respect or mobility. These are very long-term goals not immediately linked to utility or gratification. These Confucian values were built upon after the fall of Mao Zedong by the Communist party policy in education (Lafayette De Mente, 2009). For example, Callick (2013, p. 6) describes the “young pioneer” program in primary schools where party affiliation is associated with values and expectations such as “To study well, have a healthy mind and body and be politically sound.” This is an example of traditional Chinese philosophy blending with Maoist politics.

As noted above, in the West it is clear that current educational thinking is such that there is a widely-held belief that learning needs to be made attractive through being authentic and relevant. This philosophy starts in early childhood where it is recommended that children learn in “authentic” contexts, and fun or play-based learning has become a catchcry. As noted above, this approach has not gone unchallenged in the West. The Chinese view has tended instead to value discipline knowledge, whether it is fun or immediately useful or not. A further difference has been the shunning of memorisation in recent Western curricula, while it remains a central part of learning in China. Li (2004a) explains this as being due to the Chinese taking a much longer-term view of learning mathematics. In addition, Chinese students are expected to be very proficient in basic computation as a prerequisite for problem solving. In contrast, many Western education systems recommend learning basics via problem solving. This difference is evidenced by the much greater emphasis on computational perfection among Chinese students compared to Western students (e.g., in the US) reported by Cai and Cifarelli (2004) and Klein (2007). Zhang, Li, and Tang (2004) discuss the deferred teaching of problem solving in China by examining two basics. Two basics refers to the expectation that students learn basic skills and basic knowledge as essential parts of learning to problem solve. It could be concluded that the principles applied in two basics conform to Kirschner et al.’s (2006) recommendations that minimal guidance be deferred until students have sufficient prior knowledge for internal guidance.

The two basics approach to learning mathematics reflects the historical belief about problem solving and understanding in China. The most important role of primary and secondary school is to establish a strong foundation so students can problem solve in advanced mathematics. The Chinese approach considers that once basic knowledge and skills have been acquired, problem solving can be accomplished without students being hindered by computational limitations. Immediate understanding is not necessarily assumed. Thus, there has been an insistence on fast and accurate calculation of arithmetic operations with whole numbers and fractions, then with algebraic expressions. Algorithms and rules are expected to be memorised and the justifications for such rules are to be committed to memory well. This does not mean memory without understanding: Chinese students are expected to understand the principles and logic underpinning rules, and this is achieved through tailored pedagogy that has been described as “teaching with variation” (Lai & Murray, 2012; Gu, Huang, & Marton, 2004) and a “learning-questioning and learning-review instructional model” (An, 2004). The product of understanding may come some time after rules have been memorised and
used in different contexts. Once understood, rules could be applied and practised until students were quick and accurate in the processes. Li (2004a) describes four steps in Chinese students’ approach to learning: initially they commit the material to memory; next, they seek to understand the intention, style and meaning of the material; then they try to apply their understanding to situations that call for use of such knowledge; and finally they enter a deeper level of questioning and modification of the original material. This last step is interactive and verbal in nature. The idea of being quick and accurate is reinforced by the Chinese tradition of high-stakes examinations that have existed possibly since the 6th century AD (Zhang et al., 2004; Huang & Leung, 2004) and demand high memory recall, precision and speed. Teacher manuals also recommend that students be able to complete so many questions of a particular form in set times (Li, 2004b). This approach to learning mathematics has a profound effect upon classroom discourse.

The logical outcome of two basics is that since there is such a lot of material to be understood and committed to memory, teachers must endeavour to present material in what they consider the most effective sequence. Wang and Murphy (2004, p. 112) describe this as follows: “The teacher uses language to connect the well-structured activities explicitly. In this way, the student can easily organise the knowledge coherently.” Hattie (2009) describes such an approach as visible learning, where students are provided with clear definitions of learning tasks, students are required to master class activities, and teachers have a role of explicit directors of learning. In order to teach in this way, teachers are expected to be experts in their discipline and to guide students closely with little time spent on side tracks and investigations. That is, Chinese classrooms tend to be teacher-centred. There is some evidence (e.g., Lin, Luo, Lo & Yang, 2011; Ma, 1999) that Chinese teachers tend to have a more connected understanding of mathematics than many of their Western counterparts. The teacher-centred approach is also a practical necessity since classes frequently have over 40 students, so that attention to individual students in class time is limited.

The high value that Chinese parents place on academic pursuit, not just for social success but also for personal moral development, has flowed from school to after-school learning (e.g., Jensen, 2012; Huang, 2004; Zhao & M. Singh, 2010). This has taken the form of “cram” or “tutor” schools. Huang (2004) reported that there were various forms of cram schools growing in popularity in Taiwan, the most popular of which are closely aligned to the school curriculum, focusing on homework task completion and supporting the school’s academic programme. Huang reported that about 81% of students entering junior high school attended cram schools; in the main, their principal function was to foster academic excellence in particular disciplines.

**Engaged Mathematics Learning Time**

Irrespective of what the curriculum is and how it is enacted, few would argue that the amount of time spent on learning is not an important variable. Gettinger and Seibert (2011) use the term academic learning time (ALT) to refer to the amount of time during which students are actively, successfully and productively engaged in learning. In the 1980s, the importance of time as a variable in mathematics learning was a focus of considerable research (e.g., Brown & Saks, 1986; Peterson, Swing, Stark, & Waas, 1984; Seifert & Beck, 1984). The consensus was that more time spent productively on learning equated to more and deeper learning. Seifert and Beck (1984, p. 9) noted “Students appear to achieve optimally when they are listening and thinking, when teachers challenge the students’ intellect.” Gettinger and Seibert (2011) described a model for calculating ALT, starting with allocated time (according to the timetable) which is reduced by student interruptions, teacher interruptions, and transitions, to leave instructional time. Instructional time was the proportion of time remaining for instruction and this in turn was eroded by lack of procedural or substantive engagement by students, leaving little engaged time. Engaged time could then be reduced by inappropriate tasks for the students, leaving little successful and productive learning time. On the other hand, ALT can be enhanced with high levels of on-task behaviour in classrooms and focused
academic learning after school, either through unsupervised homework or through student engagement in academic learning in tutor schools or cram schools.

Academic learning time has various locations and timeslots, at school and out of school. Out-of-school academic learning is frequently called homework. Cooper, Robinson, and Patall (2006) defined homework as any task assigned by school teachers intended for students to complete during non-school hours. The consensus is that, while homework is associated with a limited gain in marks for primary school students, this gain increases in middle school and high school: students who do homework outperform 69% of those who do not (Cooper et al., 2006). Support for homework across all grades, including elementary school, comes from Marzano and Pickering (2007) and Thomson et al. (2007), who used data from the TIMSS to report that, across nations, average mathematics achievement was lower among students who did low levels of homework. Other authors (e.g., Hattie, 2009) report limited but variable gain due to homework. At Year 8 level, low levels of homework were defined as doing homework no more than twice a week and spending no more than 30 minutes each week on mathematics homework. High levels of homework commitment in Year 8 equated to homework assignment three or four times a week with each assignment being of about 30 minutes. Thomson et al. reported that 27% of Year 8 students across nations had high levels of mathematics homework, and 20% had low levels. Despite the multitude of confounding variables at play, the diversity of studies that link doing homework with improved grades suggests that a relationship exists between student completion of homework and better grades. Hattie (2009) noted that the homework most strongly associated with academic gain was short frequent homework that was closely monitored by the teacher and did not involve high-level thinking that many students would struggle to understand without a teacher’s support.

The role of sustained meaningful engagement in mathematics learning, including repetition of worked mathematical procedures, is supported by cognitive load theorists (e.g., Kirschner et al., 2006; Salden, Koedinger, Renkl, Aleva & McLaren, 2010). These authors described the critical role of committing into long-term memory facts, procedures and patterns of problem solving. Cognitive load theorists argue that, when students learn and commit mathematical facts and algorithms to long-term memory, short-term memory is free to focus on and process the unique features of a mathematical problem. This has been described as a mutually supportive relationship between procedural skill and conceptual understanding (e.g., Lai & Murray, 2012; Rittle-Johnson, Siegler, & Alibali, 2001). Conceptual understanding and fluency with procedural skills are listed as key strands in recent national standards in Australia (Australian Curriculum and Assessment Reporting Authority (ACARA), 2012) suggesting a shift towards more esoteric views of mathematics and its teaching and learning, compared to curriculum documents enacted by some Australian states, such as Queensland, where inquiry-based learning was strongly encouraged (e.g., Queensland Studies Authority, 2010). In the following section we examine how various curriculum theories are enacted in the classroom and what rituals are associated with different classroom discourse, since the expression of different cultural values in different classroom discourses is likely to result in different learning outcomes.

**Mathematical Discourse**

In this paper we draw on Parlo Singh’s (Singh, 2001; 2002) interpretation of the sociology of Basil Bernstein, specifically her work relating to the constitution of school curriculum via pedagogic discourse, that is, a set of rules governing the selection and organization of specific instructional content. According to Parlo Singh (2002) Bernstein’s concepts add a further analytic dimension to the notion of curriculum as intended (prescribed in official policy and syllabus documents), enacted (classroom instruction) and acquired (student learning outcomes). Parlo Singh (2001; 2002) describes Bernstein’s (1990, 1996) theory of pedagogic discourse as being comprised of two tenants; the first being instructional and the second being a regulative component. The instructional component can be analysed in terms of the set of skills, knowledge, and processes of mathematical disciplinary knowledge, and can be selected and organized (sequenced and paced) in the intended,
enacted and acquired school curriculum. Of crucial importance to this paper, however, is the arbitrary nature of what mathematical knowledge is selected, how it is organised and distributed to which group of students, and with what types of consequences (see Singh et al., 2013a,b). Parlo Singh’s (2001) interpretation and empirical work on Bernstein’s concept of regulative discourse is a useful framework for thinking about the arbitrary construction of school mathematics curricula, particularly in different cultural contexts. Regulative discourses constitute not only the order internal to the instructional content of mathematics curricula, but also the rules and rituals that support the moral climate of the school including power relationships. According to Singh (2001; 2002) these rules and rituals buttress the social order of schooling, and set the parameters of classroom interactions between students and the teacher as well as between the students themselves. These interactions are critical for student acquisition of knowledge and find manifestations in academic outcomes including academic learning time and also in student beliefs and feelings.

Method
In this paper we use Parlo Singh’s interpretation and extension of Basil Bernstein’s work on curriculum to interpret the empirical data about time on mathematics learning in a single middle school in suburban China, and to explore the pedagogic discourses associated with classroom academic learning time in this research site. The guiding research questions are:

1. What is the extent of academic learning time engaged in by the students (classroom-focused learning, homework engagement and tutor school engagement)?
2. What are students’ explanations for their academic learning time?
3. What motivates students to learn and to focus on academic activity in mathematics study? What hinders students’ learning of mathematics?
4. How do students feel about their classroom environment?

School Context
The subjects in this study were the students in four Year 8 classes (n=130) of a suburban state school in metropolitan Wenzhou, China. The school was number 17 Middle School. Wenzhou is an industrial city of 8 million, some 370 km south of Shanghai. The school was considered a normal school; however, it drew clientele from inner suburbs of Wenzhou so was probably considered better than average for China, since it is likely that most students had higher-than-average socio-economic status. The second author noted that the school was generally not regarded as a top government academic school. The school was selected for convenience; the second researcher knew a teacher who taught in the school, so access for classroom observation and data collection could be attained. One class was taught by the teaching friend of the first author and was unofficially considered as an extension class, while the other two classes in the sample were normal classes. Classes in this school are not streamed, but students wishing to do slightly more advanced mathematics are permitted to enrol in the extension class. Due to time constraints the first author visited the school once and surveyed two classes after observing mathematics lessons, and two additional classes were surveyed by the second author the following day. The survey data were anonymous and it is likely that the students felt free to express their views as the collection methods were seen to protect student confidentiality.

In this school, class time went from 8:00am to 11:40am (almost 3½ hours) and then from 1:00pm to 4:50pm (about 3½ hours). Thus, the total daily school time was approximately 7½ hours. Typically, mathematics occupied 6 lessons of 45 minutes each per week, thus a total of 4½ hours of formal class instruction each week.

Data collection tools
The researchers used a number of data collection methods (classroom observations, survey, drawing, interviews with teachers) to capture aspects of the regulative discourses operating in the mathematics
classrooms. The research tools also worked to produce versions of regulative discourse. Students’ talk and drawings about conduct and relations to other students, teachers and mathematical content knowledge revealed shifting patterns of classroom regulative discourses.

The data collection was conducted by the researchers during class time in the middle of the school year, in November of 2012. There were three parts to the study: first, investigating homework; second, investigating classwork; and finally, probing into what students felt about mathematics learning and what motivated or hindered their learning. A copy of the survey is contained in Appendix 1. In addition, students were asked to draw a sketch in response to the prompt, “This is what happens in a typical maths class this term.” Drawings have long been used to add form and meaning to children’s thinking (e.g., Driessnack, 2005). Driessnack conducted a meta-analysis of children’s drawings as facilitators of communication and reported that the analysis of such drawings “appears to be a relatively robust interview strategy” (p. 415). Students were also asked to provide a verbal explanation of their pictures. They were asked to draw a second picture in response to the prompt, “This is how I feel in a typical maths class this term,” and then to explain how they feel in a maths class. Asking the students to explain what they meant by the drawings, a strategy recommended by Driessnack, reduces some of the less valid aspects of interpreting what the students mean. The teachers of each class were interviewed at the end of the class in regard to why they structured the lesson as they had.

The categorisation of the drawings and their interpretation adds an additional qualitative aspect to this study. Some pictures are included in this paper to convey the nature of students’ feelings. These were classified as happy or satisfied-portrayed by smiling faces-in contrast to unhappy or some other negative feeling, such as sadness, anger, frustration or boredom—portrayed by drawings of tears, frowns and so on. The sketches drawn by students helped to triangulate the survey data. In terms of “this is what happens in this class” there were two categories—on-task behaviour and off-task behaviour. The survey questions related to academic learning time have been translated below.

1. I do mathematics homework after school (Monday to Thursday) set by the school: 1-never; 2-rarely; 3-sometimes; 4-mostly; 5-always.
2. I do maths homework after school (Monday to Thursday) for: 1) 0 to 10 minutes; 2) 11 to 20 minutes; 3) 21 to 40 minutes; 4) 41 minutes to 1 hour; 5) 1 hour to 2 hours.
3. On weekends I do maths homework: 1) never; 2) rarely; 3) sometimes; 4) mostly; 5) always.
4. On weekends I do maths homework for approximately: 1) 0 to 10 minutes; 2) 11 to 20 minutes; 3) 21 to 40 minutes; 4) 41 minutes to 1 hour; 5) more than one hour.
5. My maths teacher sets maths homework: 5) each lesson; 4) most lessons; 3) occasionally; 2) rarely; 1) never.
6. My maths teacher checks my maths homework: 5) each lesson; 4) most lessons; 3) occasionally; 2) rarely; 1) never.
7. I attend tutor school and work on mathematics each week for: 1) zero time; 2) ½ to 1 hour; 3) 1 hour to 2 hours; 4) 2 to 3 hours; 5) more than 3 hours.
8. I use a computer or the internet to help with my mathematics learning outside of school each week: 1) never; 2) ½ to 1 hour; 3) 1 hour to 2 hours; 4) 2 to 3 hours; 5) more than 3 hours.

Peterson et al. (1984) found that students’ reports of attention, understanding, and cognitive processing were valid indicators of classroom learning. Therefore, in addition to responding to the survey questions, students were encouraged to write comments in response to the following open-ended prompts:

1. The main reason I do mathematics homework is…
2. I do not do mathematics homework because…
3. I would be more likely to do mathematics homework if …

This data collection takes account of the classroom environment and the group atmosphere that a number of authors note is central to individual student behaviour (e.g., Haladyna, Shaughnessy, & Shaughnessy, 1983). Students responded in Chinese and the responses were translated and checked for accuracy by the second author. SPSS was used to collate the numerical data.
Results

The results are presented starting with survey data and open-ended verbal explanations about homework, classroom engagement, and ending with interpretation of students’ descriptions of classroom discourse, including their feelings. The translated results are summarized below.

Homework and tutor school engagement: Amount and explanations.

Table 1. Summary of homework engagement survey data (n=130)

<table>
<thead>
<tr>
<th>Prompt</th>
<th>Never</th>
<th>Rarely</th>
<th>Sometimes</th>
<th>Mostly</th>
<th>Always</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) I do mathematics homework after school</td>
<td>0%</td>
<td>0%</td>
<td>8.7%</td>
<td>13%</td>
<td>72.5%</td>
</tr>
<tr>
<td>2) I do mathematics homework after school for (minutes except for last response)</td>
<td>4.3%</td>
<td>26.1%</td>
<td>53.6%</td>
<td>13%</td>
<td>72.5%</td>
</tr>
<tr>
<td>3) On weekends I do maths homework</td>
<td>0%</td>
<td>5.8%</td>
<td>7.2%</td>
<td>21.7%</td>
<td>65.2%</td>
</tr>
<tr>
<td>4) On weekends I do maths homework for approximately (minutes except for last response)</td>
<td>1.4%</td>
<td>15.9%</td>
<td>46.4%</td>
<td>34.8%</td>
<td>1.4%</td>
</tr>
<tr>
<td>5) My maths teacher sets maths homework</td>
<td>Each lesson 50.7%</td>
<td>Most lessons 47.8%</td>
<td>Occasionally 5.8%</td>
<td>Rarely 1.4%</td>
<td>Never</td>
</tr>
<tr>
<td>6) My maths teacher checks my homework</td>
<td>Every lesson 76.8%</td>
<td>Most lessons 15.9%</td>
<td>Occasionally 5.8%</td>
<td>Rarely 1.4%</td>
<td>Never</td>
</tr>
<tr>
<td>7) I attend tutor school and work on mathematics each week for about</td>
<td>Zero time 24.6%</td>
<td>½ to 1 hour 7.2%</td>
<td>1 to 2 hours 56.5%</td>
<td>2 to 3 hours 7.2%</td>
<td>More than 3 hours 4.3%</td>
</tr>
</tbody>
</table>

The data from these classes indicate that, with few exceptions, the students do mathematics homework every week evening or most week evenings, and this takes from 20 minutes to 1 hour per evening, indicative of short-focused homework tasks rather than extended investigations. The data also indicate that students do mathematics work on weekends and most attend tutor schools where they spend at least an hour a week specifically on mathematics. It is clear that these students believe teachers regularly set and check homework as part of their daily duties. The teachers of each class were interviewed as was the head of mathematics (HOM). The HOM and the teacher of one class noted that the survey data might have underestimated the time students spend on homework, since many students would complete homework before leaving school and thus not count this time.

When asked if setting and checking of homework was standard practice in Chinese schools, a senior teacher commented:

*Chinese teachers need to mark and comment on students’ homework every day and will need to have some explanations on the homework in class if necessary. Correcting mistakes is a very important part in China’s mathematics lessons.*

This teacher also explained that tutor schools were relatively expensive but if families could afford the tuition they would usually send their children to tutor school. He suggested that the approximately 25% of students who did not go to tutor school may have had other family support, and the main reason for not going was probably financial constraints. These comments were supported by the second author, who engages with many schools in the district as part of his academic duties.

In response to the open-ended prompts, some students made two comments while some made none; most made one comment. Thus the percentages are calculated from the number of comments, and this does not equal the number of students in the sample.
Students responded to the open-ended prompts to explain why they did homework or tutor school work. Of the 127 responses, 118 (93% of responses) were of the theme “for self-improvement.” Nine reported “Because I like maths,” 9 “because it is set,” 3 “to please my parents,” 3 “to avoid punishment” and 3 “to get higher marks,” and there was 1 comment each of “to contribute to China,” “it is meaningful,” “it is my interest,” “to get a better appreciation,” “to get into a good school, and “it is my habit.”

In response to the prompt I do not do mathematics homework because …, the most common response (37 out of 104; 36%) was “I always do homework.” The next most frequent response was “I do not understand the tasks” (18%) followed by “lack of time” (7%) or “spending time on other subjects” (12%); 7% reported they “may forget” and 5% reported they might be “tired or in a bad mood”. No student reported the tasks were boring.

In response to the prompt I would do more homework if …. the most common response was “I had more time” (36 out of 142 comments; 25%), followed by “I had a better understanding” (18%). Eight percent of students indicated that they would do more mathematics homework if it was “more interesting” or if they were “more motivated”. The remaining response categories contained 5% or less of all comments, and included statements such as “there was an exam soon”, “I was required by the teacher”, and “I had a poor exam result previously.”

Academic learning time in the form of classroom academic engagement: Amount and explanations

Data on classroom academic engagement come from three sources: survey data, including student written comments and drawings; classroom observations; and commentary from the teachers.

Table 2. Summary of classwork engagement survey data (n=130)

<table>
<thead>
<tr>
<th>Survey Prompt</th>
<th>Categories (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1) I work for the following % of time in a typical maths lesson</td>
<td>Less than 10% of the time</td>
</tr>
<tr>
<td></td>
<td>1.4%</td>
</tr>
<tr>
<td>2) I work and think hard in mathematics lessons</td>
<td>Very hard 36.2%</td>
</tr>
<tr>
<td>3) My teacher helps me learn mathematics in class</td>
<td>A great deal 52.2%</td>
</tr>
</tbody>
</table>

Most students report they work nearly all lesson and describe this as very hard or hard thinking.

Responses to the open-ended prompt the main thing which holds back my maths learning is…. were categorised into six response themes, listed below:

- “problems are too difficult” (39 out of 131; 30%)
- “lack of concentration” (19%)
- “nothing” (13%)
- “time on other subjects” (9%)
- “pressure from other subjects” (9%)
- a few responses related to “laziness” (3%); “teacher’s issues” (2%); “carelessness”; “tiredness”; “lack of imagination or confidence” (1% each).

There were very few comments blaming the quality of the teaching or the nature of the subject, although some students indicated that it was hard. Students reported they would do better at mathematics if they were “more diligent” (17%); “if they understood better” (13%); “if the work was more interesting” (10%); if the “teacher explained better” (7%); “if the class had more laughter” (9%); and “if they did not get distracted” (8%); and smaller percentages of comments related to “time,” “being smarter,” “good preparation in advance,” and “being in a better mood.”
The most common response describing and explaining students’ feelings about studying mathematics was “happy” (56%), followed by “satisfied” (10%), “good relationship with the teacher” (8%), “interested” (6%), and “relaxed” (4%). That is, 84% of students reported being happy, satisfied, interested or relaxed, or having a good relationship with the teacher. In contrast, 6% reported being unhappy, 5% puzzled, and 3% worried.

In response to the question of what motivated students to study mathematics, that is, to be active in the study of mathematics, there were 163 comments (over 2 per student). Comments were of the form “to learn more” (35%); “because it was related to life skills” (14%); “to benefit the community” (12%); “because I love mathematics” (9%) or “mathematics’ fun” (4%); “for career options” (3.5%); “to get into a higher school” (4%); and a few reported they wanted “to repay the homeland.”

The sketches drawn by students, and their written commentary of classroom discourse, triangulate the survey data in regard to classroom discourse and the products of this discourse. The sketches were dominated by images of on-task behaviour, as illustrated below.

*Figures 1 and 2.* Student sketches were dominated by images of cooperative on-task behaviour where the teacher was central to the discourse.

Even when students’ sketches seemed to indicate non-conformity, it was not an indication of lack of participation.

*Figure 3.* The teacher teaches too fast and sometimes it is too hard and we do not understand it.

Similarly, student sketches and accompanying commentary depicting their feelings were dominated by positive images and explanations. The two sketches below were typical.
Usually I feel excited after maths because I learned something.

I enjoy the process of learning math, it is like food.

Figures 4 and 5. Sketches typical of Chinese students’ portrayal of feelings about learning mathematics.

There were a few sketches that revealed not all students were comfortable in mathematics class, and student commentary explains why this was the case.

I find maths difficult and get a headache.

They can do it faster than I.

Figures 6 and 7. Negative emotion in students’ drawings tended to be related to the difficulty of the subject matter or concerns about one’s own performance.

Overall, the sketches were dominated by on-task behaviour and positive feelings. Students in the main seemed to take responsibility for their learning and most negative feelings were generated by feelings that the student was not learning as well as he or she wished.

Observations and visual collaboration

Lesson observations confirmed that there was no obvious off-task behaviour. In fact the pace of lessons was such that there appeared to be very little time wasted. Figure 8 illustrates the attention of students listening to the teacher. In this instance the teacher is explaining an algebraic solution that is presented on the blackboard behind him. The teacher made statements to which students responded either individually or as a group. This was typical of the discourse in the classrooms. In the observed lessons the format and atmosphere were similar. The teacher presented problems with a data projector. He and the students discussed some of these. The students were then given time to complete some problems and the teacher subsequently modelled the solutions on a blackboard. Frequently this was accompanied by explanation or discussion, and sometimes students would contribute their solutions verbally. Student solutions were critiqued by the teacher and the class.
Figure 8. Students listen while the teacher explains the merits of a student’s explanation for an algebraic solution.

Students were very attentive to the teacher, listening, taking notes, responding quickly to any question he asked and quickly volunteering to explain solutions verbally or by writing them on the blackboard. Figure 9 illustrates the work of one such student.

Figure 9. Year 8 student completing the solution to algebraic inequalities.

(Note: In typical Australian schools this level of mathematics would not be expected until Year 10.)

The lessons were highly structured and symbolic. The observations confirmed what the students reported in their surveys, that is, they were attentive for most of the lessons, doing and thinking about mathematics, and the teacher helped them to understand mathematical concepts.

Bernstein (1975; 1990) theorised on the importance of instructional discourse being supported by regulatory discourse, an aspect of which were rituals and routines that assisted in the construction of a moral order (see also Parlo Singh, 2001; 2002). The products of these rituals were clearly evident in the observed classrooms with respectful and disciplined students focused on learning mathematics. Students were neat and in uniforms, arrived on time, had all necessary mathematical equipment, ritually greeted the teacher at the commencement of the lesson, raised their hands when requesting to speak, and afforded other students and the teacher politeness and respect. Figure 8 illustrates the ordered nature of classroom discourse: all students look at whoever is talking and appear to be actively listening. The first author moved around the classroom examining student recording of board work and their own attempts at problem solving. Student diligence in recording their work and the teacher’s explanations is further evidence of student conformity to the teacher’s expectations. The work shown in Figure 10 was typical of student recording of work and indicative of the emphasis on formal setting out of solutions and correction of any errors.
In the lesson observations there was not one incident that indicated a breach of classroom norms or manifestation of overt off-task behaviour. In short, the classrooms were highly ordered in ways that enabled the teacher to unpack the structures of mathematical problems via blackboard writing accompanied by explanation, or via Socratic discourse with the class. The data indicate that in the main, students conformed to consensual expectations and this included doing regular homework and carefully recording and completing work in class. A further ritual was observed as the researchers departed the school: Students were seen cleaning down the school playground, assembly area and buildings (see Figure 11). The first author asked if this was some form of punishment and the teacher responded, “No, all students learn to care for the school and the society. This is their choice.” This out-of-class observation is evidence of the forms of regulatory discourse designed to buttress the moral order of the institution, in this case, a sense of commitment and responsibility to the school community.

In regard to differentiating rituals, observations indicated that the school was much like many Western schools, except that classes were not formally ability streamed as they usually are in the West.

**Discussion**

The paper began by noting the superior results attained by East Asian nations such as Singapore, Taipei, Hong Kong, South Korea, Japan and mainland China in international tests of mathematics. It is worth noting that this effect is likely to be more pronounced when tests assess privilege extended
knowledge. The subjects of this paper might be unique, but this is highly unlikely. It is much more likely that the students in this school are typical of average to perhaps a little above-average Chinese mainland students in urban schools. The study school is just a small sample, but if this suburban school located in a middle-sized industrial city in China is indicative of the mathematical discourse enacted in other schools across China and beyond, it is possible to begin to see why the students from schools such as this perform so well. In the sections below we explore the nature of the pedagogic discourse observed and draw some inferences regarding the link between this discourse and academic performance.

The evaluation of curriculum documents from the West (e.g., Australia, US, UK and France) and the East (e.g., Hong Kong, Singapore, Taiwan and China) indicated a global trend to valuing what Bernstein (2000; 1996) describes as everyday or mundane knowledge as the pathway for learning mathematics. Essentially, the instructional discourse remains hierarchical, but curriculum documents encourage teachers to blur the boundaries between school and out-of-school knowledge forms and to place greater emphasis on the processes of acquiring knowledge as distinct from the discipline itself. Muller (2000) and Hattie (2009) provide a rationale for this move towards emphasising increased blurring of the boundaries between school and community knowledge forms and, in particular, how knowledge is acquired. The rationale is that by emphasising the process of mathematics, including investigations, authentic problem-based learning and discovery learning, mathematics would be more engaging for students and they would gain a deeper appreciation of its nature. Further, because much of the mathematics was to be connected to the lives of students, it was expected that the students would be more engaged. In the main, claimants who support this position come from what Muller (2000) refers to as the constructivist alliance, which he describes as dominating Western educational publications including reform curriculum documents.

An explanation of why the students in this school (and possibly in other East Asian secondary schools) may have been able to master mathematics several years in advance of what is expected of many Western students was achieved at least in part by examining academic learning time, including classroom and homework time and the instrumental and regulatory discourse that supports mathematics learning. Thomson et al. (2007) reported “high” levels of homework commitment if homework was completed three or four times a week with each assignment being about 30 minutes. This amounts to between 90 and 120 minutes each week. The responses of students in this study illustrate that about 85% of the students reported doing mathematics-specific homework always (73%) or mostly (13%), and that usually this was between 21 minutes and 40 minutes daily, while some students (about 20%) completed homework in excess of 40 minutes daily. This is clearly a very high level of homework commitment. In addition, most students had mathematics tutoring for over an hour each week and the teachers reported that in most instances tutor schools synchronised their content to match the teaching occurring in the schools and ensured that students understood the homework set by schools. Thus it is likely that many students were habitually doing double the amount of what was considered a high homework load by Thomson et al. (2007).

High levels of homework participation for students in this study were paralleled with high levels of classroom academic learning time. Classroom observations and student response on the survey instruments indicated that for most students the 4½ hours of allocated mathematics lesson time was largely on task. That is, most students (62%) reported working nearly all lesson and described the intensity of concentration as either very hard (36%) or hard (55%). These data were supported by student sketches of classroom activity, which without exception illustrated an ordered classroom where students engaged with the teacher to learn mathematics. It was clear from classroom observations and survey data that little time was wasted. There was no evidence that significant numbers of students were, as Hattie (2009, p. 32) describes, “physically present but psychologically absent.” According to researchers of academic learning time, the high total time on task, both at school and at home, and the focus of this time, may well explain why these Year 8 students were doing work that in Australia and the US is usually covered in Year 10.

Bernstein (1975; 1990) points out that how any school curriculum is implemented is dependent on the forms of instructional and regulatory discourse operating in the classroom, and these are strongly influenced by factors outside official curriculum documents that set out the parameters for
instructional discourse (see Singh et al., 2010). In the West there has been a tendency to move towards student-centred regulatory discourse and approaches variously described as minimal guidance, inquiry based, investigative, discovery-based learning and constructivist learning. As described earlier, the curriculum recommendations in the West encourage teachers to situate mathematics in authentic contexts that can be readily connected to the students’ out-of-school environment. It has been assumed that such approaches could be used as mechanisms to engage learners. The assumption underpinning this approach to learning is that if students are intrinsically motivated by what they consider is mathematics that is immediately relevant to their lives, they will be happy and have high engagement and consequently learn deeply. Indeed the relative success of a portion of students in Western nations indicates that such approaches can work. In contrast, researchers have noted that mathematics teaching in China has remained highly teacher-centred with Chinese teachers carefully controlling what is taught, how it is taught and at what pace. Various descriptions have been given of this teacher-centred pedagogy, including “teaching two basics” (Zhang et al., 2004); “teaching with variation” (Gu et al., 2004) and “learning-questioning and learning-reviewing” (An, 2004). This study adds further evidence in support of claims that such instructional discourse may well be common in China. An examination of student exercise books, follow-up discussions with the teachers, student comments and drawings all provided evidence that mathematics lessons focused on esoteric knowledge with little emphasis given to investigations, authentic contexts or autonomy. The pedagogy observed in this study are in contrast to the approaches recommended in Western curricula. In light of this, it is interesting to observe the Chinese students’ explanations about their motives for high academic learning time in classrooms where the nature of the mathematics was esoteric and the regulatory discourse teacher centred.

Almost universally, the Chinese students in this study reported they were motivated by factors including “to learn more,” “for self-improvement,” “to please my parents,” “for the rise of China,” “to repay the homeland,” or “to benefit the community.” While many students commented that the esoteric, highly structured and symbolic mathematics they were studying was “interesting,” “exciting” and “fun,” very few cited this as the main factor for studying hard. The data indicate that many students had strong extrinsic and intrinsic motivation to study hard, and cited competition from other subjects for time and a lack of personal discipline, (e.g., “if I was more diligent”; “lack of concentration”) as the main variables that limited their performance. The classroom observations, analysis of comments and student sketches indicated the students were in the main content, and indeed their survey responses overwhelmingly supported that they were “happy,” “satisfied” or “interested” when studying mathematics. About 10% of these Year 8 students reported manifestations of stress. According to dominant Western curriculum thinking, these mostly positive responses are not expected of students studying esoteric knowledge in a teacher-centred classroom. The factors that have facilitated this focus on disciplined study are described in the emerging literature on Chinese learning and culture towards which this study contributes.

While curriculum documents are an important informant of instructional discourse, as we have seen text books and teacher manuals are very important in China (e.g., Li, 2004b), as is the tradition of external examinations (Zhang et al., 2004) and consensual rituals that Bernstein (1977) refers to as implicit and explicit rules, rituals and expectations about classroom discourse. It was clear that the students in these classes simply expected to treat each other, the teacher and the discipline with respect and attention. There was evidence of these rituals at work, for example in the students cleaning the school as an act of social commitment to the broader school community. As noted by other authors (e.g., Li, 2004a; Zhang et al., 2004), the conformance to these rituals reflected a commitment to historic cultural norms that had been maintained by the current political and educational systems (e.g., Callick, 2013). The students in this study appear to manifest a convergence of factors that have facilitated the mutual supporting influence of regulatory and instructional discourses that have facilitated high engagement and limited disenchantment in the study of mathematics.
Conclusions

While on the surface, curriculum documents in the East and West appear to be heading towards common goals, other forces have the potential to nudge the instructional discourse in very different directions. It seems that different cultural norms continue to manifest themselves very differently in the East and West. It is apparent that several decades after the intervention of Mao, Confucian belief in self-perfection through a personal commitment to learning, a sense of duty and responsibility both intrinsically (e.g., self-improvement) and extrinsically (to get into a good school, to please my parents, for the good of China) remain important in Chinese schools. There is evidence that expression of these values has allowed Chinese teachers to manage classroom activity in ways that focus on fluency and understanding. To a large part, teacher-centred classroom practice can be effective because the students value mathematics and have the expectation that their teacher will help them to understand it. The data make it clear that most of these students perceived it was their role to make sense of what the teacher was explaining and to commit this to memory, in part through high homework commitment and additional learning at tutor schools. This high and focused academic engagement is likely to facilitate the mastery of basics skills, such that the teacher is able to teach with variation and explore the underpinning logic of mathematical structures.

As a Western mathematics educator, I (first author) have spent many hours observing and indeed years teaching in middle-school classrooms. I was struck by the contrasting challenges faced by the teachers. It was apparent that the Chinese teachers in this study did not have to concern themselves with making the mathematics intrinsically interesting by linking it to “authentic” contexts and mundane knowledge forms and blurring the boundaries between school and out-of-school life. In fact, I found the data quite confronting in that they call into question the assumptions upon which Western curriculum implementation has been based. Western curricula have tended to encourage teachers to make mathematics relevant and exciting by connecting it to authentic contexts and using student-centred discourses. In a sense, the responsibility for student engagement is placed upon teachers, since they have to make the work interesting and exciting. By contrast, this study adds to the evidence that the implementation of a curriculum valuing esoteric knowledge and placing the responsibility for engagement upon student discipline and sense of responsibility to themselves and to the community has manifested in high on-task behaviour and high student satisfaction.

Acknowledgement

I would like to thank Prof. Parlo Singh of Griffith University for her help in examining the data from the theoretical perspectives described by Bernstein.
References


### Appendix 1: Survey instrument

<table>
<thead>
<tr>
<th>题目</th>
<th>选项</th>
<th>选项</th>
<th>选项</th>
<th>选项</th>
<th>选项</th>
</tr>
</thead>
<tbody>
<tr>
<td>年级：</td>
<td>从未</td>
<td>很少</td>
<td>有时</td>
<td>经常</td>
<td>总是</td>
</tr>
<tr>
<td>性别：</td>
<td>0到10分钟</td>
<td>11到20分钟</td>
<td>21到40分钟</td>
<td>41分钟到1小时</td>
<td>1小时到2小时</td>
</tr>
<tr>
<td>对下面问题的回答都不会显示你的姓名，你的老师和学校不会知道你所填的内容，所以请大胆填出自你对下面问题的看法。</td>
<td>从未</td>
<td>很少</td>
<td>有时</td>
<td>经常</td>
<td>总是</td>
</tr>
<tr>
<td>1. 从星期一到星期四，每天放学后我做学校布置的数学家庭作业的情况是</td>
<td>0到10分钟</td>
<td>11到20分钟</td>
<td>21到40分钟</td>
<td>41分钟到1小时</td>
<td>1小时到2小时</td>
</tr>
<tr>
<td>2. 从星期一到星期四，每天放学后我花在学校布置的数学家庭作业上的时间大约是</td>
<td>从未</td>
<td>很少</td>
<td>有时</td>
<td>经常</td>
<td>总是</td>
</tr>
<tr>
<td>3. 周末我做学校布置的数学家庭作业的情况是</td>
<td>0到10分钟</td>
<td>11到20分钟</td>
<td>21到40分钟</td>
<td>41分钟到1小时</td>
<td>超过1小时，大约是</td>
</tr>
<tr>
<td>4. 周末我花在学校布置的数学家庭作业的时间大约是</td>
<td>从未</td>
<td>很少</td>
<td>有时</td>
<td>经常</td>
<td>总是</td>
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<tr>
<td>5. 我的数学老师布置家庭作业的情况是</td>
<td>每节课</td>
<td>大部分课</td>
<td>偶尔</td>
<td>很少</td>
<td>从未</td>
</tr>
<tr>
<td>6. 我的数学老师检查我的家庭作业的情况是</td>
<td>每节课</td>
<td>大部分课</td>
<td>偶尔</td>
<td>很少</td>
<td>从未</td>
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<tr>
<td>7. 通常，在一节数学课上，我听讲和学习的时间所占的比例大约为</td>
<td>低于10%</td>
<td>11%到25%</td>
<td>26%到接近一半</td>
<td>一半到75%</td>
<td>差不多整节课</td>
</tr>
<tr>
<td>8. 我在数学课上学习与思考</td>
<td>非常努力</td>
<td>努力</td>
<td>一般</td>
<td>不努力</td>
<td>非常不努力</td>
</tr>
<tr>
<td>9. 老师在课堂上对我学习数学所起的帮助</td>
<td>非常多</td>
<td>多</td>
<td>一般</td>
<td>少</td>
<td>非常少</td>
</tr>
<tr>
<td>10. 我每周参加补习班学习数学的时间大约是</td>
<td>没有</td>
<td>半小时到1小时</td>
<td>1小时到2小时</td>
<td>2小时到3小时</td>
<td>超过3小时</td>
</tr>
<tr>
<td>11. 我每周在课外利用计算机或网络辅助数学学习的时间大约是</td>
<td>从未</td>
<td>半小时到1小时</td>
<td>1小时到2小时</td>
<td>2小时到3小时</td>
<td>超过3小时</td>
</tr>
<tr>
<td>12. 请简单描述你用来辅助数学学习的计算机软件或程序</td>
<td>从未</td>
<td>半小时到1小时</td>
<td>1小时到2小时</td>
<td>2小时到3小时</td>
<td>超过3小时</td>
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</table>
请在下面的空格中写上几句话来描述你的数学学习。
我做数学家庭作业的主要原因是……

我不做数学家庭作业的主要原因是……

如果……，我可能会做更多的数学家庭作业。

阻碍我的数学学习的主要事情是……

如果……，我在数学课上可能会学得更好。

请在下面的方框中画一张图来表达这个学期你对数学学习的感受或想法。然后简单描述这张图。

以下是这个学期的数学课堂上经常发生的事情：

请简单解释你上面画的图。
请画一张图来展示你在课堂上学习数学时的感受。

以下是在这个学期的数学课上我通常的感受:

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请简单解释在数学课上你通常的感受以及为什么你会有这种感受:

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你学习数学的动机是什么?

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你学习数学的最大的障碍是什么?

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