Chapter 2-3

CLASSIFICATION AND FRAMING OF MATHEMATICAL KNOWLEDGE IN HONG KONG, MAINLAND CHINA, SINGAPORE, AND THE UNITED STATES

An Analysis of Textbooks in Socio-Cultural Contexts

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Curriculum – that is, the selection, organization, and transmission of educational knowledge – can contribute to students' cognitive development, and at the same time, transmit specific social-cultural values and regulatory norms. With a focus on identifying curricular influence on students' academic achievement,[1] researchers have come to understand that cross-system variations in curriculum can provide a partial explanation of cross-system variations in students' academic performance, especially in mathematics (Fuson, Stigler and Bartsch, 1988; Schmidt, McKnight and Raizen,1997; Schmidt, McKnight Valverde, Houang and Wiley, 1997;

[1] It is important to consider whether performance on standardized examinations, emphasizing content knowledge, should be the only or main measure of the quality of education. For example, it is argued that mathematics curriculum and teaching in China tends to focus on students' acquisition of traditional content knowledge, which may be emphasized in international studies of achievement, while in the United States more stress may be devoted to developing students' skills of solving practical problems in everyday life [see James W. Stigler, & M. Perry, "Cross cultural studies of mathematics teaching and learning: Recent findings and new directions," in D.A. Grouws, T.J. Cooney, & D. Jones (eds.), *Effective mathematics teaching*, (Reston, VA: NCTM, 1988), pp.104-223]. Moreover, as J. Wang ["TIMMS primary and middle school data: some technical concerns," *Educational researcher* 30(6) (August/September 2001):17-21] observes concerning TIMMS middle school level achievement data, there are "technical problems that can alter the comparative results, undercutting the reliability of TIMMS benchmarking" (p.17).

Westbury, 1992). In particular, when compared to the curriculum materials from some high-achieving education systems in East Asia, research has revealed that the U.S. curriculum materials failed to provide challenging mathematics content (Li, 1999; Schmidt et al., 1997a; Mayer, Sims and Tajika, 1995). "Both the Second International Mathematics Study (McKnight et al., 1989) ... and the Third International Mathematics and Sciences Study (Schmidt, McKnight, Valverde, Houang and Wiley, 1997)[5] ... found American textbooks to be more fragmented and superficial than texts in most other countries." (Kennedy, 1997:8) Findings such as these have provided a basis for considering curricular changes in the United States. (Mathematical Sciences Education Board, 1990; Silver, 1998)

Meanwhile, curriculum also embodies the values and norms, including those concerned with authority relations, of a specific society. Thus, curriculum can serve as a window through which to examine the cultural features that support or resist instructional and social changes in a given educational system and societal context. However, when comparative studies focus primarily on the impact of mathematics curriculum on students' cognitive outcomes, the social-cultural substance reflected in curricula are overlooked or trivialized as merely surface phenomena (Reid, 2000). Fortunately, this stance has been undermined as recent research in mathematics education has examined how students' learning in classrooms is also a process of social construction (Bussi, 1996; Lerman, 1998).

This study is not aimed to explore the potential relationships between curriculum and students' achievement. Rather, the purpose of this study is to examine mathematics curriculum as a system and societal artifact that reflects both culturally valued knowledge and principles of social control. Specifically, because textbooks are often the curricular materials that are the most influential to what happens in classrooms (Eisner, 1987; McKnight et al., 1989), this study examines mathematics textbooks from the United States and three education systems in East Asia (Hong Kong, mainland China, and Singapore) to reveal cross-system variations in knowledge selection and organization as well as in envisioned pedagogical relationships between teacher and students. The results, in turn, may also provide a basis to predict the feasibility of possible proposals for curricular change.

1. CONCEPTUALIZATION

Our conceptualization is based on the work of Basil Bernstein's (1975a)[2] sociological analysis of the curriculum, which centers on two key concepts, classification and frame. Bernstein defines *classification* in terms of the degree of "differentiation between contents," whether contents are traditional subject areas (mathematics, economics, physics, etc.) or are topics or sections within one subject area (Bernstein, 1975a:88). "Where classification is strong, contents are well insulated from each other by boundaries." (Bernstein, 1975a) According to Bernstein, *frame* "refers to the strength of the boundary between what may be transmitted and what may not be transmitted in the pedagogical relationship ... to the degree of control teacher and[/or] pupil possess over ... the knowledge transmitted and received in a pedagogical relationship." (Bernstein, 1975a) The stronger the frame, the less flexibility teacher and students have to control what is taught and learned in the context of the pedagogical relationship. Moreover, the concept of frame has another aspect that addresses "the strength of boundary between educational knowledge and everyday community knowledge." (Bernstein, 1975a:89).

Importantly, as Bernstein clarifies, the tension between strongly or weakly classified and framed curricula "is not simply a question of what is to be taught but a tension arising out of quite different patterns of authority, quite different concepts of order and control." (Bernstein, 1975b) As Apple observes, "the logic and modes of control ... are entering the school through the form the curriculum takes, not only its content." (Apple, 1981:30) Thus, cross-system differences in content classification and framing may reflect differences in authority patterns characterizing the societies' political cultures. Likewise, intra-system differences in content classification and framing may correspond to differences in the nature of authority relations of groups (for example, social classes) which predominate in particular educational tracks.

[2] For discussions of Bernstein's framework, see Ann and Harold Berlak, *Dilemmas of Schooling: Teaching and Social Change* (New York: Methuen, 1981); John Eggleston, *The Sociology of the Curriculum* (London: Routledge and Kegan Paul, 1977); Alan Sadovnik (ed.), *Knowledge and Pedagogy: The Sociology of Basil Bernstein* (Norwood, NJ: Ablex, 1995); Geoff Whitty, *Sociology and School Knowledge: Curriculum Theory, Research and Politics* (London: Methuen, 1985); Michael F.D. Young, "An Approach to the Study of Curricula as Socially organized Knowledge," in M. Young (ed.) *Knowledge and Control* (London: Collier-Macmillan, 1971).

2. METHODS

This study focuses on the United States and three high-achieving educational systems in East Asia: Hong Kong,[3] mainland China, and Singapore. Nine mathematics textbooks developed for eighth graders in these four education systems were analyzed in this study, the same books that were used in the "Third International Mathematics and Sciences Study" (TIMSS) (Schmidt et al., 1997b). Among these nine textbooks, five textbooks were from the United States, one from Hong Kong, two (actually a two-volume set) from mainland China, and one from Singapore.[4] Among the five U.S. textbooks, one was an algebra-specific textbook (hereafter, US-Algebra or US-A) and four others were popular non-algebra-specific mathematics textbooks de-signed for use in the eighth grade (hereafter, US-Non-Algebra or US-NA).[5]

To assess the degree of classification of mathematical knowledge in each system the student versions of these texts were content analyzed. Two text levels were used in the analysis: (1) chapters within a book and (2) sections within a chapter. For each of these levels, the degree of separation of content was assessed with respect to two content contrasts: (a) between mathematics and non-mathematics content topics and (b) between algebra and non-algebra content.[6]

To determine the strength of framing, two types of information were collected. The first type of information focused on the organization of these

[3] Note that the textbooks from Hong Kong used in this study were published in 1992 – before, but during the period anticipating, Hong Kong's change from being a British colony to becoming again a part of China.

[4] *Mathematics for Hong Kong Book 2* (Hong Kong: Canotta Publishing Co., Ltd., 1992); *Daishu/Algebra*, Vol. 3 (Beijing: People's Education Press, 1993); *Jihe/Geometry*, Vol. 1 (Beijing: People's Education Press, 1992); *New Syllabus: Mathematics 2* (Singapore: Shing Lee Publishers Ltd., 1987); *Addison-Wesley Mathematics*, Grade 8 (USA: Addison-Wesley, 1993); *Exploring Mathematics*, Grade 8 (USA: Scott Foresman, 1991); *Mathematics in Action*, Grade 8 (USA: MacMillan/McGraw Hill, 1992); *Mathematics - Exploring Your World*, Grade 8 (USA: Silver Burdett and Ginn, 1991); *Algebra: Structure and Method Book 1* (USA: Houghton Mifflin Co., 1990).

[5] For other details about the textbooks studied, see Yeping Li, *An analysis of algebra content, content organization and presentation, and to-be-solved problems in eighth-grade mathematics textbooks from Hong Kong, Mainland China, Singapore, and the United States*.

[6] Content classifications at the levels of both chapter and section were determined by their titles and content included (at least 75% page space were devoted to the content category classified). The TIMSS curriculum framework [see Robitaille et al., *Curriculum frameworks for mathematics and science* (Vancouver: Pacific Educational Press, 1993)] was adopted for differentiating mathematics content presented in the textbooks.

four educational systems, which would help to reveal the degree of control that teacher and students may have over the selection and transmission of educational knowledge. In particular, the existence of system-wide syllabi and the degree of individual teachers' autonomy in selecting and/or using mathematics textbooks were examined. Moreover, the teacher's versions of these texts were content analyzed, with attention being focused on guidelines that encouraged or discouraged teachers and/or students to bring in knowledge from outside the official curriculum as examples, etc.

Finally, secondary sources were consulted to characterize the political cultures, especially norms concerning authority, in each society.[7]

3. RESULTS

The findings are presented below, first focusing on the classification of mathematical knowledge and second portraying the framing of such knowledge.

3.1 Classification

The following table summarizes the classification of contents exhibited in eighth grade textbooks across four educational systems: Hong Kong, mainland China, Singapore, and the United States.

Level	*Content Contrast*	*Hong Kong*	*PR China*	*Singapore*	*United States*
Chapters within a Book	*Math vs. Non-Math content topics*	100% math	100% math	100% math	US-A: 100% math US-NA: 100% math
	Algebra vs. Non-Algebra	Both (29% algebra chapters)	Both (33% or 75% algebra chapters)*	Both (50% algebra chapters)	US-A: Both (83% algebra chapters) US-NA: Both (13%, 13%, 14%, & 21% algebra chapters)
Sections within a Chapter	*Math vs. Non-Math content topics*	100% math	100% math	100% math	US-A: 100% math US-NA: Both (72%-96% math topic section contained in a chapter)
	Algebra vs. Non-Algebra	100% algebra or non-algebra	100% algebra or non-algebra	100% algebra or non-algebra	US-A: Both (95% algebra sections in algebra chapters)

[7] For example, see M.A. Brimer, "Hong Kong"; C.C. Dong, "China, People's Republic of"; R. Murray Thomas, "Singapore".

Level	*Content Contrast*	*Hong Kong*	*PR China*	*Singapore*	*United States*
					US-NA: Both (76%, 80%, 86%, & 96% algebra sections in algebra chapters)

* Note: In Mainland China, two texts (actually a two-volume set) were used together for eight graders. One is an Algebra text (containing 4 chapters, three of which are identified as chapters on algebra content), and the other is a Geometry text (containing 5 chapters). Thus, if we counted in terms of the whole eighth grade as we did for other educational systems, there were three out of nine chapters (33%) on algebra. If counted in terms of the book that contains algebra content, three out of four (75%) chapters in Algebra text are on algebra content.

The results show that the selected texts from these four education systems are similar in that all of the texts have 100% of their chapters focused generally on math content topics. That is, in terms of the contrast between math and non-math topics, our analysis examining the content focus at the level of chapters indicates that all the textbooks examined are strongly classified. A weaker classification would be evidenced if a textbook had at least some chapters devoted primarily to content other than mathematics.

However, as we continue to examine the results of the chapter-level analysis, we observe important cross-national (as well as some intra-U.S.) differences in the classification of mathematical knowledge. In particular, the textbooks from Hong Kong, Mainland China, and Singapore contain approximately one-third to one-half (respectively, 29%, 33%, and 50%) of their chapters that focus primarily on Algebra topics, while the US-Non-Algebra textbooks contain approximately one-seventh to one-fifth (13%-21%) of their chapters that present mainly algebra topics. In contrast, more than four-fifth (83%) of the chapters in the US-Algebra textbooks have a primary focus on Algebra topics.

When we review the findings for the analyses at the level of sections within a chapter, the cross-system differences in degree of classification of mathematical knowledge become even more apparent. Specifically, whether we consider contrasts in content with respect to math vs. non-math topics or algebra vs. non-algebra, the textbooks from the three Asian education systems are very strongly classified. That is, the sections in a given chapter of a textbook all contain a homogeneous set of content topics. The Asian textbooks differ from those used in the U.S., especially the non-algebra texts, which tend to be much more weakly classified. All the U.S. textbooks differ from the Asian textbooks, in that they contain heterogeneous contents within a chapter with respect to the algebra vs. non-algebra content contrast. Note however, that 95% of the sections in algebra chapters in the US algebra text

focus on algebra topics, while the percentages for the U.S. non-algebra texts tend to be lower (76%, 80%, 86%, and 96%).

In examining the math vs. non-math topic contrast, we note that the U.S. non-algebra textbooks also differ from the Asian system textbooks, in that the former texts have a weaker classification of mathematical knowledge than the latter texts. That is, unlike the eighth grade texts used in the Asian systems, the chapters in the U.S. non-algebra textbooks contain a mixture of section topics, including math as well as non-math topics such as "Curriculum Connection: Art" and "Enrichment" (Stevenson and Stigler, 1992).[8] In this content contrast, however, the U.S. algebra textbook resembles the Asian system textbooks, evincing a strong classification of mathematical knowledge (100% of its content sections are focused on math content topics).

3.2 Framing

Hong Kong, mainland China, and Singapore have a centralized education system, and all three differ from the United States that has a decentralized education system.[9] In particular, curriculum guides and textbooks used in these three Asian education systems are required to bear an approval from a national or system-level authority. Teachers and students system-wide are required to cover the same content that is specified in syllabi and textbooks. In contrast, the United States leaves such responsibilities of developing curriculum guides and selecting textbooks to states, local school districts, schools, or even individual teachers.[10] In contrast to

[8] Stevenson and Stigler elaborate based on a similar finding; they note that in contrast to textbooks used in elementary schools in mainland China, Taiwan, and Japan, the U.S. texts for mathematics and other subjects contain many "colorful illustrations, photographs, drawings, or figures [, which] ... along with digressions into historical and biographical material, ... introduced to engage children's interest, ... may instead distract attention from the central purpose of the lesson" (p.139).

[9] A. Beaton, I. Mullis, M. Martin, E. Gonzalez, D. Kelly, & T. Smith, *Mathematics achievement in the middle school year: IEA's Third International Mathematics and Science Study (TIMSS)* (Chestnut Hill, MA: TIMSS International Study Center, Boston College, 1996).

[10] It should be noted, however, that despite the opportunities for decentralized curricular decisions, there is a standardizing of texts in the United States. This occurs because of the major role played by a small and decreasing number of textbook publishers (generally part of multinational corporations) and their profit-motivated efforts to design texts that will be adopted in large states (e.g., California, New York, and Texas), which have state-level adoption procedures. See, for example, Michael Apple and Linda Christian-Smith (eds.), *The Politics of the Textbook* (New York: Routledge, 1991). At the same time the combination of (multi)national publishers and local/state text adoption means that (at least) eighth-grade mathematics textbooks tend to "include the content specified by the

what is often said in China that the "textbook is the base for classroom instruction," it is not uncommon in the United States for teachers not to follow or use any specific textbooks as they are published for many different school districts. Therefore, in these three Asian education systems, teachers and students have almost no flexibility in determining what is taught and learned (except some modifications on content topic sequencing and pacing). But teachers (and perhaps students) in the United States have had, until recently, somewhat more say in shaping the curriculum followed and the textbooks used, indicating a weaker framing of mathematics knowledge.

The texts from Hong Kong and Singapore do not have accompanying teacher's instructional guides or teacher's version of texts. Teachers were assumed to use the same textbooks as their students. The mainland China texts have accompanying teacher's guides, which provide instructional suggestions for teaching each chapter. In general, the guide contained (1) general instructional requirements, (2) textbook analysis and instructional suggestions, (3) answer keys or hints for the exercise problems, (4) appendices with additional information related to the content contained in a given chapter in the student's version text. The guide is very condensed with most of its page space devoted to textbook analysis, instructional suggest-ions and answer keys. Even for the textbook analysis and instructional suggestions, the guide mainly highlights the key and/or difficult concepts in each chapter and offers suggestions for teaching these concepts. There is no specific encouragement for teachers or students to bring in knowledge from outside the official curriculum. Although mainland China differs from Hong Kong and Singapore in providing instructional guides for teachers, all three are centralized educational systems. In such contexts, teachers are required to teach students the knowledge presented in textbooks.

In contrast, all U.S. texts have teacher's versions, organized similarly as an expanded version of the student's text. The format presents instructional suggestions alongside the content material that appears in the student's text. Furthermore, they all include detailed instructional suggestions and extra examples for almost every lesson to aid the teacher's use of the textbook. The student's versions of the five U.S. texts contain higher percentages of problems situated within real world contexts (e.g., about 11-18% in algebra

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guidelines from a number of different states" [Lois Peak, *Pursuing excellence: A study of U.S. eighth-grade mathematics and science teaching, learning, curriculum, and achievement in international context* (Washington, DC: U.S. Department of Education, National Center for Education Statistics, 1996), p.36]. This may partly explain the finding (reported later) that eighth-grade mathematics textbooks in the US, especially those not designed for Algebra classes, exhibit a lower degree of classification and framing than is the case for eighth-grade texts in Hong Kong, mainland China, and Singapore.

chapters), compared to the three Asian texts (1.5-5.7% in algebra chapters). The frame around mathematical knowledge is further weakened in the teacher's version of the U.S. texts, in which many more examples related to real world or other non-math content areas are provided. Moreover, the texts present clear and strong suggestions to teachers (and, through teachers, to students) to bring in knowledge from outside the curricular knowledge specified in the text. For example, in the section on "Writing Algebraic Sentence" in "Mathematics in Action" (student edition) published by MacMillan/McGraw-Hill, the content was introduced in the context of comparing two persons' money sums in a foreign currency. In its teacher edition, it was suggested for teachers to start the lesson by asking students whether they have lived or traveled in a foreign country. If so, ask students to identify the currency used. Then the following problem was suggested to the teacher to continue the discussion:

> If a person from the United States went to a bank to change $1,000 for foreign currency, would the person be getting 1,000 units of the foreign currency? Why or why not? (p.92)

Likewise, in the section on "Greatest Common Factor" in "Exploring Mathematics" (student edition) published by Scott, Foresman and Company, the content was introduced in a pure mathematics context in the student's text. In the teacher edition, it was suggested to teachers to motivate students through proposing the following situation to students:

> You are in charge of designing a banner for your school, and it is to have a border of squares in the school colors. (p.168)

This would be followed by questions:

> If the banner is 45x40 inches, what is the largest square that can be used for the border? [5 sq in.] How many squares will fit along the 40 in. side? [8 squares] (p. 168, the italic and parentheses were original.)

We should note, however, that compared to the teacher's editions of the U.S. non-algebra texts, those for the U.S. algebra text indicate a stronger frame around mathematical curricular knowledge. In the teacher's edition of the latter text, far fewer instructional suggestions were given in the margin of the text. Except for some suggestions/additions of pure mathematical problems that are similar to what are given in the student's text, no explicit examples or suggestions were given to teachers (and their students) to bring in everyday, out-of-school knowledge in their lessons.

4. DISCUSSION

In interpreting the findings we will focus on three sets of contrasts: a) the three East Asian systems versus the U.S., b) similarities and differences among East Asian systems, and c) algebra versus non-algebra texts used in the United States (most likely with students from, respectively, upper middle and middle class backgrounds. versus lower middle and working class backgrounds).

4.1 Differences among East Asia and the U.S.

According to the results, the three Asian systems' mathematics textbooks exhibited a higher degree of classification and framing than either the US algebra or the US non-algebra books.[11] In attempting to understand the higher degree of classification and framing of mathematics knowledge in Hong Kong, mainland China, and Singapore (compared to the United States), we can point to the differences in authority relations in the dominant political cultures of these societies.[12] Employing Wilson's concept of "compliance ideologies,"[13] we can say that East Asian political cultures tend to be dominated by a *positional* compliance ideology, which stresses "forms of control that emanate ... from the community" and relationships in which

[11] Similarly, Bernstein ["On the classification and framing," p. 92] concluded that, compared to England and continental Europe, the "course-based, non-specialized USA [curriculum pattern had] ... the weakest classification and framing."

[12] Here we focus on what have been described as the dominant political culture extant in the contexts of the respective educational systems. This is not to deny the existence of one or more subordinate political cultures or subcultures in each setting. Similarly, while Hong Kong, Mainland China, and Singapore share a cultural root and the majority of residents in each setting are Chinese, there are a variety of minority groups living in the three settings. And although the population in the United States is dominated (numerically and politically) by people who emigrated from Europe, an increasing proportion of the population have their cultural origins in Africa, Asia, and Latin America. [See M.A. Brimer, "Hong Kong," in T.N. Postlethwaite (ed.) *The encyclopedia of comparative education and national systems of education* (Elmsford, NY: Pergamon Press, 1988), pp.332-38; C.C. Dong, "China, People's Republic of," in Postlethwaite (ed.) *The Encyclopedia*, pp.197-201; R. Murray Thomas, "Singapore," in Posthlethwaite, *The encyclopedia*, pp. 594-597.]

[13] Note that Wilson's conception of positional versus contractual "compliance ideologies" or forms of authority associated with different political cultures is paralleled by Bernstein's conception of positional versus personal forms of authority associated with family and classroom cultures of different social classes (working versus middle, respectively), which we will discuss below. See Basil Bernstein, "Social class, language and socialization," in *Class, Codes and Control, Volume I: Theoretical Studies towards a Sociology of Language* (London: Routledge and Kegan Paul, 1971), pp.170-89.

"duties are matched against rights in terms of one's place in society." (Wilson, 1992:89) In contrast, the United States tends to be dominated by a *contractual* compliance ideology, which emphasizes "defined limits of authority, the intrinsic value of the individual, and legal guarantees regarding negotiating processes." (Wilson, 1992:89)

According to Yee (1999), a fundamental element of the political culture of China is an emphasis on "paternalistic-dependency" relations between leaders and their followers:

The hallmark of Chinese political culture ... is the 'displays of deference by subordinates and grace in asserting command by superiors.' (Pye, 1998:32) Confucianism was the mainstream ideology of imperial China because 'it fitted the ideals and needs of both the rulers in their political realm and the common people in their family and clan settings.' (Pye, 1998:34) The hierarchical order of a Confucian society thus dominated the relationship between rulers and the followers in traditional China." (Pye, 1985:205)

Similarly, Hong Kong exhibits one important aspect of traditional Chinese political culture, a strong paternalistic orientation "reminiscent of [Confucianism-influenced] traditional Chinese expectations of the government: 73 percent of respondents agreed, and 8.2 percent agreed very much, with the statement that 'the government should treat the people like a father treats his children.'" (Pye, 1985:205) And the culture of authority manifest in Singapore's political system also seems to be more in line with what Wilson labels as a positional (rather than a contractual) form of compliance ideology:

[C]ore values of Singapore are defined in Confucian terms. ... Confucian rulers are expected to exercise power hierarchically, yet with decorum and respect for their followers. [And followers are expected to demonstrate] ... [r]espect for superiors[, which] often manifests itself as unquestioning, even obsequious, behavior toward those in authority (Neher, 1999:47-8).

In contrast to mainland China, Hong Kong, and Singapore, which have been strongly influenced by Confucianism, the dominant political culture of the United States seems to be more in line with what Wilson terms a contractual form of compliance ideology. As Verba and Nye explain in their often-cited book on *The Civic Culture*:

In the United States ... independent government began with republican institutions, and a mood that rejected the majesty and sacredness of traditional institutions, and without a privileged aristocratic class [in contrast to Great Britain]. ... In an even broader sense ... the general pattern of authority in American social systems, including the family, tended to stress political competence and participation rather than obedience to legitimate authority (Almond and Verba, 1963/1989:35-36).

The contrast in authority relations in the political cultures of mainland China, Hong Kong, and Singapore, on the one side, and the United States, on the other, also obtains with respect to the organization of their educational systems that have been mentioned before. In particular, the three East Asian educational systems are highly centralized, while the United States has a relatively decentralized education system (Beaton, Mullis, Martin, Gonzalez, Kelly and Smith, 1996). Moreover, teachers of eighth grade mathematics are more likely to have specialized content knowledge training in the Asian systems than in the U.S., which is in line with expectations that teachers' specialization would be greater in systems with strongly classified and framed curricula (what Bernstein terms a "collection code") (Bernstein, 1975:116-56) than in systems with weakly classified and framed curricula (what Bernstein terms an "integrated code") (Bernstein, 1975:116-56). That is, middle school teachers in Hong Kong, mainland China, and Singapore are required to be content specialists, while middle school teachers in the United States, until recently, were not required to have specific certification to teach mathematics.[14]

Different strength patterns of knowledge framing are also consistent with authority relationships that can be observed in classrooms between the U.S. and the three Asian education systems. In the United States, teachers are encouraged to make use of a variety of curriculum materials and pedagogical approaches in their classrooms. In particular, student cooperative learning in small groups is a popular approach in U.S. mathematics classrooms. This allows teacher and students themselves to bring everyday knowledge into the teaching and learning process. In contrast, mathematics classroom instruction in Hong Kong, mainland China, and Singapore is often didactic with the teacher assuming the role of lecturer. As teachers themselves have very limited autonomy in determining what is taught, students are assumed only to follow the teacher's instruction and requirements. The consistency between knowledge framing in texts and authority relationships in classrooms shows steps of social reproduction through schooling and classroom instruction.

4.2 Similarities and differences among East Asian systems

Our study showed that there are more similarities than differences among these three East Asian systems. All three Asian texts are strongly classified and, although the evidence with regard to framing is less clear in Hong Kong

[14] As part of efforts to improve U.S. students' performance in mathematics, there has been a trend in the U.S. for middle school mathematics teachers to become content specialists.

and Singapore texts, it appears that the framing of mathematical knowledge is similarly strong in all three Asian systems. This finding is consistent with the general social-cultural context that these three educational systems share.

However, we should also note that the math textbooks from Hong Kong and Singapore were written in English (versus Chinese), a residue of the fact that Hong Kong and Singapore (but not mainland China) were British colonial territories (Brimer, 1988; Thomas, 1988). Moreover, Hong Kong and Singapore contain a mixture of cultural elements from the East and West. In particular, "Singaporeans practice Western competitive individualism in the economic pursuits." (Haas, 1999:1, 3) Hong Kong also has been described as having "a mixed political culture with characteristics resembling traditional Chinese political culture and those 'imported' from the West."[15] Because of the role played by the English language and because of the influence of non-Confucian (i.e., western, individualist) culture, one might expect the textbooks from both Hong Kong and Singapore to be somewhat more like the ones used in the United States, in terms of classification and framing, than is the case for mainland China's textbooks. This suggests that further studies are needed to examine possible subtle differences embedded in curriculum that reflect social-cultural influences.

4.3 Differences between algebra and non-algebra texts in the U.S.

Our findings indicate that the US-Algebra textbook exhibits a higher degree of classification and framing than the US-Non-Algebra textbooks. Because of the social class stratified curricular tracks in many schools in the United States (Oaks, 1985; Persell, 1977; Spring, 2000), this probably means that textbooks with stronger classifi-cation and framing (what Bernstein terms a *collection code*) are more likely to be used with eighth graders from middle and upper middle class families, while the textbooks exhibiting weaker classification and framing (what Bernstein terms an *integrated code*) would be used in classrooms populated predominantly by students from lower middle and working class families.

This is interesting in light of previous theoretical and empirical work based in England. For example, Bernstein (Bernstein, 1975:116-56) theorized that a strongly classified and framed curriculum is likely to be preferred by families that have explicit, pre-defined, formal (*position-oriented*) authority relations, as tends to be the norm among members of the

[15] Yee, p.12; drawing upon and quoting from Lau Siukai and Kuan Hsinchi, *The Ethos of the Hong Kong Chinese* (Hong Kong: The Chinese University Press, 1988), pp.71-74.

old (or lower) middle class and working class. In contrast, Bernstein postulated that new (or upper) middle class families, which tend to manifest implicit, continually negotiated, informal (*person-oriented*) authority relations, are likely to prefer weakly classified and framed curricula.[16] However, MacDonald (MacDonald, 1977:33) observed that in schools in England in the 1960s and 1970s a weakly classified curriculum was more likely to be introduced in secondary modern schools, which were disproportionately populated by students of working class and lower middle class families, which might be characterized as having position-oriented authority relations.

Thus, our findings here appear to be in line with McDonald's observations and seem to contradict Bernstein's theorizing. This conclusion, though, must be considered in light of the differences in the status of knowledge as organized in mathematics or other subjects within the "competitive academic curriculum." (Connell, 1985) Perhaps family preferences for the type of knowledge code vary depending on the status of the subject area or perhaps the traditional ideas regarding the control and organization of knowledge by academic experts outweighs the preferences of families.

5. CONCLUSION

The finding that the differences in the societal norms of authority match with differences in the degree of classification and framing evidenced in textbooks suggests that it may be very difficult to change the curriculum and pedagogy organized through textbooks without also pursuing the more challenging task of altering societal norms regarding the nature of authority relations in a given society. At the same time, the findings that there are variations in classification and framing among Asian nations and (more so) among different texts used in the United States suggest that there may be some room for creative intervention, even in the context of countervailing norms regarding authority. The study illustrates the complexity of curriculum reform and suggests the importance of examining the socio-cultural characteristics before seeking to adopt curriculum practices from another system. Otherwise, without full consideration of the "conditions under which

[16] Note that Bernstein's conception of position-oriented versus person-oriented authority relations in families is parallel to Wilson's conception of positional and contractual compliance ideologies relations associated with societal level political cultures (see earlier discussion).

certain foreign practices deliver desirable results,"[17] (Noah, 1986:162; LeTendre, Baker, Akiba, Goesling and Wiseman, 2001) simple adoption of foreign practices may constitute an "abuse" of comparative education. Meanwhile, this study shows the value of examining knowledge codes signaled by the organization and control of curriculum content knowledge. It opens another window through which we can examine possible opportunities and resistances along the process of knowledge selection, transmission, and evaluation in a society.

REFERENCES

Almond, Gabriel and Verba, Sidney, 1963/1989, *The Civic Culture: Political Attitudes and Democracies in Five Nations*, Sage Publications, Newbury Park, CA.

Apple, Michael, 1981, Reproduction, Contestation and Curriculum: An Essay in Self Criticism, *Interchange*, (Fall):30.

Beaton, A., Mullis, I., Martin, M., Gonzalez, E., Kelly, D., and Smith, T., 1996, *Mathematics Achievement in the Middle School Year: IEA's Third International Mathematics and Science Study (TIMSS)*, TIMSS International Study Center, Boston College, Chestnut Hill, MA.

Bernstein, Basil, 1975a, On the Classification and Framing of Educational Knowledge, in: *Class, Codes and Control, Volume 3: Towards a Theory of Educational Transmission*, Routledge and Kegan Paul, London.

Bernstein, Basil, 1975b, On the Curriculum, in: *Class, Codes and Control, Volume 3: Towards a Theory of Educational Transmission*, Routledge and Kegan Paul, London.

Bernstein, Basil, 1975c, Class and Pedagogies: Visible and Invisible, in: *Class, Codes and Control, Volume 3: Towards a Theory of Educational Transmission*, Routledge and Kegan Paul, London, pp.116-156.

Brimer, M.A., 1988, Hong Kong, *The Encyclopedia of Comparative Education and National Systems of Education*, in: T.N. Postlethwaite, ed., Pergamon Press, Elmsford, NY, pp.332-38;

Bussi, M.G. Bartolini, 1996, Mathematical Discussion and Perspective Drawing in Primary School, *Educational Studies in Mathematics*, **31**:11-41.

Connell, Robert , 1985, *Teachers Work*, George Allen and Unwin, Sydney, Australia.

Eisner, E., 1987, Why the Textbook Influences the Curriculum, *Curriculum Review*, **26**(3): 11-13.

Fuson, Karen, Stigler, James and Bartsch, Karen, 1988, Brief Report: Grade Placement of Addition and Subtraction Topics in Japan, Mainland China, the Soviet Union, Taiwan, and the United States, *Journal for Research in Mathematics Education*, **19**(5):449-456.

Haas, Michael, 1999, The Singapore Puzzle, in: *The Singapore Puzzle*, Michael Haas, ed., Praeger, Westport, CN, 1999.

[17] Note with caution, however, "that the unspecified assumptions inherent in an image of national cultures leads to too much idealization and celebration of national differences" (p. 13), when in fact global dynamics yield degrees of similarity across nations with respect to educational and societal structures and cultures.

Kennedy, Mary, 1997, The Connection between Research and Practice, *Educational Researcher*, **26**(7):8.

Lerman, S., 1998, Research on Sociocultural Perspectives of Mathematics Teaching and Learning, in: *Mathematics Education as a Research Domain: A Search for Identity: An ICMI study*, Book 2, A. Sierpinska and J. Kilpatrick, eds., Kluwer, (Dordrecht, The Netherlands, pp.333-350.

LeTendre, G., Baker, D., Akiba, M., Goesling, B., and Wiseman, A., 2001, Teachers' Work: Institutional Isomorphism and Cultural Variation in the U.S. Germany, and Japan, *Educational Researcher*, **30**(6) (August/September):3-15.

Li, Yeping, 1999, *An Analysis of Algebra Content, Content Organization and Presentation, and To-be-solved Problems in Eighth-grade Mathematics Textbooks from Hong Kong, Mainland China, Singapore, and the United States*, Unpublished University of Pittsburgh doctoral dissertation, Pittsburgh, PA.

MacDonald, Madeline, 1977, Culture, Class and the Curriculum, in: *Culture, Class and the Curriculum and the Politics of Curricular Reform* [Schooling and Society, Block III: Knowledge, Ideology and the Curriculum], Roger Dale and Madeline MacDonald, eds., Open University Press, Milton Keynes, England.

Mathematical Sciences Education Board, 1998, *Reshaping School Mathematics: A Philosophy and Framework of Curriculum*, National Academy Press, Washington, DC.

Mayer, Richard, Sims, V., and Tajika, H., 1995, A Comparison of How Textbooks Teach Mathematical Problem Solving in Japan and the United States, *American Educational Research Journal*, **32**:443-460.

McKnight, C.C., Crosswhite, F.J., Dossey, J.A., Kifer, E., Swafford, J.O., Travers, K.J., and Cooney, T.J., 1989, *The Underachieving Curriculum: Assessing U.S. School Mathematics from an International Perspective*, Champaign, Stipes, IL.

Neher, Clark, 1999, The Case for Singapore, in: *The Singapore Puzzle*, Michael Haas, ed., Praeger, Westport, CN.

Noah, Harold J., 1986, The Uses and Abuses of Comparative Education, in: *New Approaches to Comparative Education*, Philip Altbach and Gail Kelly, eds., University of Chicago Press, Chicago, IL.

Oaks, Jeannie, 1985, *Keeping Track: How Schools Structure Inequality*, Yale University Press, New Haven, CN.

Persell, Caroline Hodges, 1977, *Education and Inequality: The Roots and Results of Stratification in America's Schools*, The Free Press, New York.

Pye, Lucian, 1998, *The Mandarin and the Cadre: China's Political Cultures*, Center for Chinese Studies, University of Michigan, Ann Arbor, MI.

Pye, Lucian, 1985, *Asian Power and Politics: The Cultural Dimensions of Authority*, Harvard University Press, Cambridge, MA.

Reid, W.A., 2000, Curriculum as an Expression of National Identity, *Journal of Curriculum and Supervision*, **15**:113-122.

Schmidt, W.H., McKnight, C.C., and Raizen, S.A., 1997a, *A Splintered Vision: An Investigation of U.S. Science and Mathematics Education*, Kluwer Academic Press, Dordrecht, the Netherlands.

Schmidt, W.H., McKnight, C.C., Valverde, G.A., Houang, R.T., and Wiley, D.E., 1997b, *Many Visions, Many Aims (Volume 1): A Cross-national Investigation of Curricular Intentions in School Mathematics*, Kluwer Academic Press, Dordrecht, the Netherlands.

Schmidt, W.H., McKnight, C.C., Valverde, G.A., Houang, R.T., and Wiley, D.E., 1997c, *Characterizing Pedagogical Flow: An Investigation of Mathematics and Science Teaching in Six Countries*, Kluwer Academic Press, Dordrecht, the Netherlands.

Silver, Edward, 1998, *Improving Mathematics in Middle School: Lessons from TIMSS and Related Research*, U.S. Department of Education, Washington, D.C.

Spring, Joel, 2000, The Social Structure and American Education, in: *American Education*, 9th edition, McGraw Hill, New York.

Stevenson, H., and Stigler, J., 1992, *The Learning Gap: Why our Schools are Failing and What We can Learn from Japanese and Chinese Education*, Summit Books, New York.

Thomas, R. Murray, 1988, Singapore, in: *The Encyclopedia of Comparative Education and National Systems of Education*, in: T.N. Postlethwaite, ed., Pergamon Press, Elmsford, NY, pp.594-597.

Westbury, Ian, 1992, Comparing American and Japanese Achievement: Is the United States really a Low Achiever?, *Educational Researcher*, (June-July):18-24.

Wilson, Richard, 1992, *Rethinking Political Culture*, Cambridge University Press, Cambridge, UK

Yee, Hebert, 1999, *The Political Culture of China's University Students: A Comparative Study of University Students in Mainland China, Hong Kong, Macao, and Taiwan*, Nova Science Publishers, Commack, NY.