Searching for evidence of curricular effect on the teaching and learning of mathematics: Lessons learned from the two projects

Yujing Ni a, Jinf Cai b,*

a The Chinese University of Hong Kong, HKSAR, China
b University of Delaware, Newark, USA

ARTICLE INFO

Keywords:
Longitudinal studies
Education reform
Mathematics education

ABSTRACT

The two research projects described and discussed in the special issue provided much needed longitudinal empirical data to show the curricular influence on classroom instruction and student learning outcomes. The findings have helped to advance our understanding of whether the reform curricula can bring about positive changes in classroom instruction and student learning outcomes and how such changes might be sustained. In this article we synthesize the results from the two studies and discuss several lessons learned from the projects about investigating and understanding curricular effects on the teaching and learning of mathematics.

© 2011 Published by Elsevier Ltd.

The articles in this special issue report the findings from the two longitudinal studies that investigated the central questions of how mathematics curricula influence classroom instruction and student learning in China and the United States. In this final article, we first examine the convergence and divergence of evidence from the two projects relating to curricular effects on the teaching and learning of mathematics. Then we discuss the lessons we learned from the projects. The article concludes with a discussion of new developments underway in these projects that aim to further the efforts to clarify the interdependence among curriculum, teaching and learning.

1. Evidence of curricular effects on teaching and learning of mathematics

Given the history of curriculum reform in many countries, successful implementation at the classroom level cannot be assumed (Track and Cuban, 1995). The current projects were implemented to address the demand for evidence of the effectiveness of the new curricula. Four key questions were investigated in the projects concerning curricular effects on the teaching and learning of mathematics and we restate them here:

(1) Does the use of a reform curriculum affect the quality and nature of classroom teaching?
(2) Do students gain more in solving problems as prescribed by the reform curricula?
(3) Are basic mathematical skills sacrificed in students with a reform curriculum?
(4) To what extent does the use of a reform curriculum improve the learning of mathematics for all students?

The answers to these four questions are quite interesting and basically affirmative across the two projects. Both projects provided consistent evidence for questions 1 and 4, but the evidence for answers to questions 2 and 3 is somewhat different.
between the two projects. The US project provided positive evidence for questions 2 and 3. However, the Chinese project provided neither positive nor negative evidence for these two questions. In what follows, we discuss the evidence associated with each of the four questions.

**Question 1**: does the use of a reform curriculum affect the quality and nature of classroom teaching?

Before discussing the findings to answer the question, it is important to note some significant differences in the observation methods between the two projects. Primarily, the US project used on-site observations in the classrooms, whereas the Chinese project used videotaped class sessions as the source of the classroom data. The US's observation schemes were to capture the 'instructional profile' of classroom instruction. This was achieved by observing the distribution of instructional time into the different lesson activities, characterizing different uses of the textbook, and evaluating a conceptual or procedural emphasis of the instruction. (The U.S. project also analyzed instructional tasks, but the findings have been reported in other articles due to space limitations of this special issue; Cai, Wang, Moyer, & Wang (Submitted).) In contrast to this 'panoramic observation' of classroom instruction, the Chinese project used 'close-up' observations that focused on features of instructional tasks that were implemented in classroom by the teacher and the students and the classroom discourse that took place between the teacher and their students.

In addition to the differences in the classroom observation methods, it is significant to note that the focus of the classroom observations for both projects related more to pedagogy than to specific mathematical topics. This strategy was necessary because a major purpose of the projects was to quantitatively establish the association between curriculum and classroom instruction on the measured dimensions. Although it might have been desirable to observe lessons on the same topics in both projects, in reality this was not always feasible.

Another notable feature of the projects was that multiple observations of the same classroom were made. In the US project each classroom was observed four times with two consecutive lessons in the fall and another two consecutive lessons in the spring. In the Chinese project, each classroom was observed for three consecutive lessons.

The findings of both projects illustrate that the reform and the non-reform classrooms differed significantly on most of the measures of classroom instruction. Specifically, instruction in the US reform classrooms had more conceptual emphasis than the instruction in the non-reform classrooms. The Chinese reform classroom used more learning tasks with higher cognitive demands, involving multiple representations, and multiple solution strategies than the non-reform classrooms.

The instruction used in the reform classrooms provided students with more opportunities to work on challenging academic activities. Instruction in both the US and the Chinese reform classrooms also showed evidence of the tendency to allow students more time for active learning. In comparison to their non-reform counterparts, the US reform classrooms spent more time on student group work and student presentations. The teachers in Chinese reform classrooms asked more questions that required students to describe procedures leading to their answers and to explain reasoning underlying their answers. The results of the two projects indicated that there was converging evidence for the positive effect of the reform curricula on the quality and nature of classroom instruction.

**Questions 2 and 3**: do students gain more in solving problems as prescribed by the reform curricula? Do students sacrifice basic mathematical skills with a reform curriculum?

Both projects used multiple indicators, particularly, the open-ended tasks, to measure student learning outcomes and to investigate achievement gains over time. The US project examined students’ performance from 6th grade to 8th grade and the Chinese project followed the students from 5th grade to 6th grade. The Chinese project employed three cognitive measures (computation, simple problem solving, and complex problem solving), two affective measures (interest in learning mathematics, classroom participation) and two belief measures (view of mathematics and views of learning mathematics). The results of the Chinese project showed that, after controlling for student SES, both the reform and non-reform groups showed significant improvement on the cognitive measures over time. However, the achievement gain in the measures indicated that there was no difference between the reform and the non-reform group. The only exception was that the non-reform group showed a faster rate of improvement on computation. Neither group showed significant changes in the affective and belief measures over time except for a decline in the students' expressed interest in learning mathematics from their fifth grade to sixth grade.

The US project used four cognitive measures: translation, computation, equation solving, and solving open-ended tasks. As indicated in the first article of this special issue, the computation tasks in the US project are equivalent to the computation tasks in the Chinese project. The open-ended tasks in the US project are equivalent to the complex problem-solving tasks in the Chinese project. Translation in the US project is one of the three components in the simple problem-solving tasks in the Chinese project (the remaining two are integration and planning). Reform students showed more gains than the non-reform students on two measures, translation and solving open-ended tasks. The two groups did not differ in growth rate on the other two measure, computation and equation solving. The US project also examined whether or not a conceptual emphasis or procedural emphasis in classroom instruction would affect students' achievement growth rates. The results were that this effect was found only for translation.

The multiple achievement measures as well as the layers of statistical analysis in the two projects provide a relatively complete picture of student achievement using the different types of curricula. The US data demonstrate clearly that compared to the non-reform group, the students in the reform group gained more in solving open-ended problems. In addition, the reform students did as well as the non-reform students in doing basic computation. The Chinese data indicate that the reform group and non-reform group progressed at a similar pace in solving open-ended problems and routine problems. However, the non-reform group showed more gains and outperformed the reform group in computation.
The US student data indicated that in solving open-ended problems the reform students performed better than the non-reform students. Also, the US reform students did not sacrifice any of the basic skills in computation and equation solving. The Chinese student data showed that reform students did not gain more than non-reform students in solving the open-ended tasks. However, they were able to maintain the higher scores in solve open-ended tasks obtained on the first assessment. On the other hand, the non-reform students surpassed the reform students in computation skills. The results of the Chinese project suggest a possible trade-off between developing high-order thinking skills and basic computations. This point will be discussed in the next section ‘Lessons Learned from the Projects’.

**Question 4:** to what extent does the use of a reform curriculum improve the learning of mathematics for all students?

Both projects closely examined the issue of equity concerning whether or not students from different social and cultural backgrounds would progress comparably. The US project found that there was no association between students’ ethnicities and achievement gains. The Chinese project also showed that discrepancies in performance between higher and lower SES students did not increase during the observation period for students receiving either curriculum. In fact, on the measure of computation the performance gap narrowed significantly for both groups. In addition, the lower SES students in the non-reform group showed a greater improvement than the corresponding students in reform group. The results of the two projects showed no indication that the reform curricula had benefited one group of students more than the other groups of different backgrounds.

The results of the two longitudinal studies from the two distinctive contexts demonstrated clearly the curricular effects on classroom instruction and student learning outcomes. Differences in the curricula were reflected in differences in the measured dimensions of instruction in classrooms. The performance patterns of the students using the different curricula appeared to reflect the relative emphasis on computational proficiency or skills in solving open-ended problems by the respective curricula. From this perspective, to some degree, the new curricula appeared to be effective in achieving the intended changes in classroom instruction and in student achievement with respect to open-ended problem solving. These findings are encouraging, especially as both projects were undertaken in ordinary schools and classrooms. Thus, the findings presented here from the two projects will have broader implications.

2. Lessons learned from the two projects

‘Change in education is easy to propose, hard to implement, and extraordinarily difficult to sustain’ (Hargreaves and Fink, 2006, pp. 28). The results of the two projects raise expectations and pose challenges for sustaining and deepening the desirable changes as a result of curriculum reform. Moreover, change is difficult to document. The two projects have provided two valuable cases to reflect on in order to better understand how curriculum may influence teaching and learning and to inform future research in the field.

The primary purpose of the projects was to establish the association of curriculum materials with student learning outcomes because this is considered critical to determine the effectiveness of a curriculum. However, curriculum materials are not the only agent that influences student learning. Indeed, the researchers assumed that classroom instruction, where teachers and students interact with curriculum materials, played a mediating role. Therefore, curriculum materials, classroom instruction, and student learning outcomes constituted the fundamental framework of the projects. Both projects examined the intended, implemented, and achieved aspects of curriculum. Therefore, the discussion below on lessons learned is organized around these three aspects.

**Intended curriculum:** the intended curriculum basically refers to curriculum materials, mainly curriculum standards, textbooks, and teacher manuals. An analysis of the intended curriculum took the form of content analysis (Cai, 2010; National Research Council, 2004; Stein, Remillard, & Smith, 2007), such as, the worldviews or orientations towards the subject matter, depth of coverage, ways to sequence topics, ways to present topics, and accuracy. The US project completed a detailed content analysis that compared the structural and functional treatment of algebra in the reform and non-reform curricula (Cai, Nie, & Moyer, 2010: Nie, Cai, & Moyer, 2009). The Chinese project provided a general description of the purpose and objectives of the new curriculum but did not include a detailed content analysis. Instead, the researchers in the Chinese project made some assumptions about the differences between the intended and implemented curricula. One assumption was that the highly centralized curriculum system in the country would facilitate alignment of the intended curriculum with the implemented curriculum. In China, Ministry of Education (2001) issues the national curriculum standards for all school subjects included in compulsory education. Based upon the standards, a few publishers are designated by the government to develop all textbooks and teacher manuals. Upon approval by the government, the textbooks and teacher manuals that have been developed can be published and provided to teachers and students. During the next phase of research on curriculum effectiveness undertaken by the Chinese project, an analysis of the content of the intended curriculum will need to be enhanced in order to establish explicit links between curriculum, instruction, and student learning.

**Implemented curriculum:** classroom instruction was observed in both projects. An investigation of the way in which the implementation took place in the classrooms provided insight into the process of change. There were several challenges related to the observation of classroom instruction for both the comparative and longitudinal study. One was the unit of observation, classroom or teacher or teacher-cum-classroom. The classroom, not the teacher, was the observation unit in the US project because a teacher did not teach the same class from grade to grade and because the study was to examine whether or not certain features of classroom instruction would affect student learning. Therefore, the US project used INSTRUCTION as
a ‘place holder’ to characterize the variations between classrooms in terms of the nature and quality of classroom instruction. The Chinese project was able to use teacher-cum-classroom as the observation unit because the teacher was with the same class for the entire study period. When the classroom serves as the unit of observation, it introduces an additional source of variance from different teachers for a classroom and it creates a challenge to isolate the variance in later analysis. However, in the US project, a teacher might have taught multiple classes at a grade level. The US researchers found that there was only small variation among those classes taught by the same teacher at a particular grade level. The experience from the US project suggested that it is sufficient to observe only one of the classes taught by the teacher.

The second issue was concerned with what to observe about a lesson as classroom instruction in real time involves a web of events, individuals, materials, and locations. The US project used the observation schemes to capture an ‘instructional profile’ of classroom instruction in terms of time distributions for different lesson activities, different uses of textbook, and conceptual or procedural emphasis of the instruction, as well as the instructional tasks. By contrast, the Chinese project used a ‘close-up’ observation that focused on the cognitive features of implemented instructional tasks and of classroom discourse. For both the US project and the Chinese project, those aspects of classroom instruction to be observed was, in part, selected according to the respective curriculum standards. The aspects chosen by each project may also reflect the different research interests in classroom instruction for the US and the Chinese teams. In addition, these differences might have something to do with the research regulations in the two countries. For example, it has become more difficult in US for a researcher to videotaped lessons. However, the observation schemes were able to capture the meaningful patterns of classroom teaching that were of interest to both teams, and they were appropriate for the purpose of looking at the general impact of curriculum change on classroom instruction. However, it seemed that the observation schemes were not able to accommodate contextual variations. For example, a teacher’s question with the same surface feature may have different functions. In addition, it is difficult to determine whether use of a textbook, in one way or another, is appropriate when taken out of context. It also was difficult to determine the precise unit of analysis, especially when the phenomenon under study involved a continual, evolutionary process of give and take by teachers and students working together on curriculum materials (Mercer, 2010; Nystrand, Wu, Gamoran, Zeiser, & Long, 2003). Therefore, it was important to use other methods, particularly, qualitative methods, to complement what was lost in the research that sought to quantify the identified variables of classroom instruction.

Achieved curriculum: student learning is the ultimate goal of any curriculum reform or innovation (Stein et al., 2007). This objective was also at the core of the two current projects. The projects were post-hoc efforts to evaluate curricular impacts on teaching and learning. As such, it was necessary to examine the sequence of learning in a continuing process, instead of relying on only a brief, static glimpse of student achievement. This being said, one challenge was to create comparable groups of students in order to determine where there were any differences that could be associated with the curricula (National Research Council, 2004). The US project was able to obtain and to use the prior achievement of the students to create the comparable groups statistically, in addition to using the procedure of randomly selecting reform schools, and then selecting comparable non-reform schools. However, this was not possible in the Chinese project. The researchers could not equate the groups because they lacked prior achievement data. This resulted in a high degree of uncertainty about the results of student learning outcomes. The problem might have been alleviated if the Chinese team had administered an intelligence test and used it as a control variable in the analyses. However, a problem would have remained because an intelligence test score has only a moderate correlation with school achievement. This underscores the importance of obtaining adequate information about students prior to the beginning of a study in order to create comparable groups if the study is to be comparative in nature.

Another significant issue was the selection of the particular learning outcomes to be measured. Both projects are to be commended for using multiple outcome measures to gain fine-grained understanding of student performance in relation to task demands and to the respective curricula. In addition, the Chinese project measured both cognitive and affective domains. Affective learning outcomes are significant objectives of the new mathematics curricula but are often neglected in evaluating curricular effectiveness. For the assessment of cognitive learning outcomes, both projects adopted a generic approach to measuring the outcomes in the sense that the assessment tasks were not designed to tap the particular content of the respective curricula. Rather, the assessment tasks were developed according to the cognitive analysis of processes used to solve mathematics word problems (Mayer, 2003) and routine and non-routine mathematics problems (Cai, 1995, 2000). A concern may be raised as to whether or not the generic approach would favor reform groups or non-reform groups. In theory, the approach is assumed to be fair to both groups because the three dimensions of cognitive achievements in mathematics were established based on patterns of student mathematics achievement in general and on an analysis of cognitive processes required to solve them. However, at a technical level, a developer of the measures has to be careful to make sure particular test items used in the measures are new to students receiving different curricular so that the measures would be fair to the groups of students in the implementation of the measures. In both projects, advisory board members and a group of local educators were asked to review the items and ensured that the items are not favor to any groups.

The benefit of assessing students’ mathematical achievement based on the cognitive processes that had already been indentified and validated by other researchers was that the validity of the investigation was enhanced. The generic approach also has the advantage of allowing for reasonable comparability of test scores over time and between populations (e.g., Ni, 1997). For example, PISA (Programme for International Student Assessment) uses the generic approach to develop its assessment tasks in order to compare the effectiveness of educational systems in various nations. The approach, however, may limit the relevancy of the measures to the concrete content of the local curricula. An ideal approach for the evaluation of curriculum effectiveness should include both student assessments based on the generic analysis of mathematics
competence and those based on the content analysis of local curricula. However, implementation of these criteria certainly would require significantly more resources.

The student learning outcomes from the Chinese project suggested a possible trade-off between developing high-order thinking skills and basic computation skill. This trade-off involves both a value inquiry and further theoretical and empirical inquiry. Is the trade-off worth it if there is one? Ni, Zhou, Li, & Li et al. (in preparation) argue that it is worth it. One reason they give is that one of the targets of the new mathematics curriculum is to improve students’ competence in solving non-routine mathematics problems, an area of weakness in previous studies of Chinese students’ mathematics achievement (Cai, 2004; Cai and Hwang, 2002; Wang and Lin, 2005). Another reason is that the students receiving the new curriculum demonstrated adequate performance with basic computations and a more balanced development in other areas of mathematics achievement. So, the question arises: Is the trade-off real in theory? Researchers in general acknowledge that procedural and conceptual knowledge are two distinct, but interrelated types of knowledge; in fact, several studies have shown substantial correlations between them (Cai, 1995; Ni et al., in preparation; Rittle-Johnson and Siegler, 1998; Rittle-Johnson, Siegler, & Alibali, 2001). Therefore, it is difficult to think the ‘trade-off’ holds theoretically. Nevertheless, the trade-off could occur in reality. Instructional time for any single classroom session is limited, and therefore it is possible that teachers could spend more time on one type of knowledge than another. Also, it is quite possible that some teaching methods facilitate skill learning and other teaching methods facilitate conceptual understanding (Hiebert and Grouws, 2007). Curriculum reforms recommend a problem-solving approach that aims to ensure that students can acquire both types of knowledge (e.g., Carpenter et al., 1999). In addition, the current reform curricula emphasize learning with understanding and helping students learn more actively and more reflectively (Schoenfeld, 1992, 1994) in addition to acquiring knowledge and skills.

To understand the ‘trade-off’ in theory and to make the judgment about the merits of the trade-off in the Chinese context, among others, three types of empirical evidence must be obtained. The first is concerned with relationships between the different dimensions of mathematics competence. The second requires longitudinal tracking of the development of the different mathematics competencies in students receiving the new curricula. The third type of evidence needs to look into comparative results involving Chinese students using international assessments.

**Linkage among the three aspects of curriculum:** It has been established that theory-driven evaluation is concerned with understanding the process that produces outcomes derived from educational intervention and consequently help to achieve program improvement (Ni, 2010; Weiss, 1998). This is consistent with the thinking of the multiple representations of curriculum – intended, implemented and achieved – and their interrelationship. Considerable efforts were made for the duration of both projects to determine how the curricula were implemented in the classroom. This was achieved by conducting in-depth classroom observations that were not only time consuming but also required a great deal of human and financial resources. These efforts were successful in providing detailed descriptions of classroom instruction that clearly demonstrated the curricular influence on the observed aspects of instruction. The links between curriculum and instruction were relatively clear. However, it was difficult to establish the association between the measured classroom instruction and the measured student learning outcomes, although in theory it should not be difficult (Hiebert and Grouws, 2007). The US project did not detect a statistically significant impact from either conceptual or procedural emphases on the student achievement gains in students’ problem-solving or symbol manipulation skills (Cai et al., this issue). However, the researchers used cognitive demand of instructional tasks as a classroom variable and found that this variable was a significant predictor of achievement gain in the students receiving either the reform or non-reform curriculum (Cai et al., 2010). For the current Chinese project, an investigation is now being conducted that only involves the reform classrooms in order to examine the relationship of the cognitive features of instructional tasks and student learning outcomes (Ni et al., in preparation). Preliminary results indicate that the cognitive features (cognitive demands, multiple representations, and multiple solution-strategies) of instructional tasks do not predict achievement gain on any of the cognitive learning outcomes (computation, routine problem solving, and complex problem solving). Also, the only feature to show positive and consistent influence on affective measures is the cognitive demands of instructional tasks, and in turn, the affective outcomes affect the cognitive outcomes.

Several issues relate to the difficulty of linking specific classroom processes to specific learning outcomes. For one thing, the configuration of individual, event/activity, and curriculum material in classroom changes frequently. In addition, student learning outcomes in a given subject matter are a result of multiple influences, including, but not limited to, the teacher’s approach to instruction, the value that the principle and the school place on the subject, the curriculum adopted by the school, and different familial and community factors (e.g., Ni, Chiu, & Cheng, 2009). Consequently, to understand what is happening at one level, it is often necessary to understand other levels. However, it remains problematic in research, for example, to disaggregate the value that is added to student learning by individual teachers from those that are added as a result of school factors (Robinson and Campbell, 2010).

Identification of process variables in classroom instruction continues to be a challenge, particularly those that lead to student learning and growth. The current projects have demonstrated that there are significant differences in instruction between the reform and non-reform classrooms. However, there are questions yet unanswered regarding how the measured aspects of classroom instruction are related to the student learning outcomes. Another important question to be addressed is whether generality exists between the measured aspects of classroom instruction and the student learning outcomes across nations.

There are limitations of the generic approach that has been adopted by the projects to assess the student learning outcomes. This method could result in the measured attributes of classroom instruction being less sensitive to the variability in the student learning outcomes. This potential problem was due to the fact that the generic approach could reduce the
relevancy of the measures to the concrete content of the particular curricula. Also, related to the generic approach to the assessment of student learning outcomes, another issue dealt with the factor of timeframe in relation to the measured classroom instruction and the measured student learning outcomes. The observed student learning outcomes accrued over a very long period of time; that is, from approximately kindergarten to the end of elementary education for the Chinese students. There were only 3 or 4 points of observation of classroom instruction that were conducted in the projects. These were quite sporadic, with respect to the long period of time that had shaped the student learning outcomes. In part, this situation might also provide an explanation for the difficulty in being able to establish the link between the measured classroom processes and the student learning.

Involvement with these two projects has been a humbling experience for the researchers, providing them with greater appreciation for the challenges involved in unraveling and understanding the myriad of variables involved in determining the influence of a curriculum on student learning. This process has emphasized the importance and challenge of providing evidence-based descriptions of the impact of the curriculum on student learning and teaching practice.

3. Moving forward of the projects

The projects presented in this special issue represent an attempt to build process models that will help clarify the interdependence between curriculum, teaching, and learning. These should be rooted in a firm empirical base and be used to inform educational practice. This constitutes a lasting challenge for researchers in curricular evaluation. Such scholarly endeavor goes beyond providing proof about learning outcomes because it considers classrooms using reform curricula as venues for studying basic questions about learning (Kilpatrick, 2003). Plans are already being formulated for further research to expand the findings of the current Chinese and the US projects.

Researchers involved with the US project are following the cohort of middle school students for another four years to investigate how the use of different types of middle school mathematics curricula affects the learning of high school mathematics in the same urban school district. More importantly, the researchers will examine how students’ curricular experience in middle grades affects their algebra learning in high school by providing empirical evidence about the relations between the development of conceptual understanding, symbol manipulation skills, and problem-solving skills in middle school and the learning of mathematics in high school.

The findings from the current US Project (see Cai et al., in this issue) are similar to the findings from research studies of the effectiveness of Problem-Based Learning (PBL) on the performance of medical students (Barrows, 2000; Hmelo-Silver, 2004; Norman and Schmidt, 1992; Vernon and Blake, 1993). That is, using a PBL approach to train medical students, researchers found that PBL students performed better than non-PBL (e.g., lecturing) students on clinical components in which conceptual understanding and problem-solving ability were assessed. However, PBL and non-PBL students performed similarly on measures of factual knowledge. When these same medical students were assessed again at a later time, the PBL students not only performed better than the non-PBL students on clinical components, but also on measures of factual knowledge (Norman and Schmidt, 1992; Vernon and Blake, 1993). This result may imply that the conceptual understanding and problem-solving abilities learned in the context of PBL facilitate the retention and acquisition of factual knowledge over longer time intervals. As we indicated before, in the US project, the CMP curriculum, which was the reform curriculum, can be characterized as a problem-based curriculum. Analogous to the results of research on the learning of medical students in the PBL approach, CMP students outperformed non-CMP students on measures of conceptual understanding and problem solving during middle school. In addition, CMP and non-CMP students performed similarly on measures of computation and equation solving. Therefore, it is reasonable to hypothesize that the superior conceptual understanding and problem-solving abilities gained by CMP students in middle school may result in better performance on a delayed assessment of manipulation skills such as equation solving, in addition to better performance on tasks assessing conceptual understanding and problem solving in high school. This will be investigated in the further work of the US project.

The Chinese researchers plan to identify a more meaningful unit to analyse and characterize classroom discourse that may serve as proximal indices of students’ learning outcomes by a more detailed analysis of the videotaped class sessions. Extended discourse, referring to continued questioning and discussion after an answer has been provided (Leinhardt and Steele, 2005; Schleppebach, Perry, Miller, Sims, & Fang, 2007), will be targeted for future investigation. The presence of extended discourse goes beyond the discourse form of Initiation–Response–Evaluation (Cazden, 1988; Mehan, 1979; Mercer, 2010; Nystrand et al., 2003). In addition, it emphasizes considerable and substantive interaction about the ideas of a topic. It also provides the opportunity for students to articulate ideas and opinions, to make connections through a broad spectrum of knowledge as well as to real-life, and to deepen their conceptual understanding. The investigation of extended discourse and the relationship to students’ cognitive and affective learning outcomes with the reform and non-reform classrooms will follow. Such investigation is likely to provide new insight into the relationship between curriculum, instruction, and learning from the Chinese perspective.

In summary, the two projects presented in this special issue have provided much needed longitudinal empirical data from two unique and distinctive settings. They have demonstrated the clear influence of the curriculum on classroom instruction and student learning. The findings have helped to advance our understanding of whether the reform curricula could bring about changes in classroom instruction and student learning, thus informing reform strategies and research designs to effect and sustain the consequential changes of the curriculum innovations. A considerable amount of conceptual and empirical work, both qualitative and quantitative, is needed in order to build the process models that will explain how educational
inputs produce educational outcomes. The questions associated with this research will be on-going and not easily resolved. The projects in this special issue represent only a part of the journey but provide an important step for further research on this critical topic.

Acknowledgement

Preparation of this article was supported by grants from the National Science Foundation (ESI-0454739 and DRL-1008536) and Research Grant Council of HKSAR, China (CERG-462405; CERG-449807; CUHK Direct Grant-4450199) and the National Center for School Curriculum and Textbook Development, Ministry of Education of People’s Republic of China. Any opinions expressed herein are those of the authors and do not necessarily represent the views of the funding agencies.

References


