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Intertwining Research and Teacher Development in Lebanese Elementary Mathematics Classrooms: The MARAL Project

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The work described herein is being conducted in the context of a worldwide increased emphasis on high level thinking, reasoning, and communication in mathematics classrooms in order to increase students' abilities to solve problems, think and reason in flexible, critical, and creative ways, and to gain conceptual, meaningful understanding of the mathematics they are learning. This mathematics education reform movement aims to establish a new vision of mathematics teaching and learning that is characterized by a focus on the active, generative processes engaged in by doers and users of mathematics that involve the use of mathematical knowledge and tools to systematically explore and reflect upon patterns and mathematical objects, to frame problems, and to justify reasoning processes, among other ideas (NCTM 1989; 2000; Schoenfeld, 1994). These same updated approaches to mathematics instruction at the school level have also been advocated by educators and curriculum designers in several developing countries, including Lebanon. Four years ago Lebanon launched a new elementary mathematics curriculum aimed at reforming instruction so as to engage students in more high-level thinking, reasoning, and communication. Indeed, the four overarching strands of mathematical problem solving, communication, connections, and reasoning as described in NCTM (1989) appear intact in the official scope and sequence document of the Lebanese curriculum (National Center for Educational Research and Development [NCERD], 1999). These ideas are also reflected to varying degrees in the textbooks currently in use in many Lebanese schools, including those developed by NCERD. The MAthemathics Reform for All in Lebanon (MARAL) Project has attempted to both study this reform and to support it through teacher development. Little systematic study of Lebanese classrooms exists; however, it is widely believed that typical mathematics instruction in Lebanon is characterized by a focus on memorization and procedural practice, especially after grade six when students begin facing high stakes national examinations that are oriented toward achievement in procedural and mechanistic mathematical skills. In Lebanon, researchers have recently begun to articulate the necessity for careful study of classroom instructional processes in mathematics (Jurdak, 2001). The MARAL project was begun partly in order to launch such a research agenda in Lebanon.

Inquiries into the MARAL database have pointed to a variety of classroom-based factors that may influence whether elementary students in Lebanon engage in high level mathematical thinking, reasoning and communication, including the nature of verbal and written communication, use of language and literacy, as well as the established classroom norms, including level of dependence on the teacher or text, the use of explanation and justification, and the ways in which both teachers and students respond to errors during instruction (Henningsen & Zebian, 2003). All of these classroom conditions may serve to influence the ways in which students come to understand the mathematical concepts and processes with which they are engaging in school.

Effectively engaging students in tasks requiring rote memorization and drill and practice is far less difficult than maintaining high level thinking in mathematics classroom (Stein, Grover, & Henningsen, 1996). The kinds of mathematical tasks and classroom environments needed to support student engagement in high level thinking and reasoning require a change from the traditional roles of teachers, students, and tasks in the mathematics classroom (Hiebert & Wearne, 1993; Henningsen & Stein, 1997; Boaler, 1998; Henningsen, 2000). Of particular concern in Lebanon, where relatively few teachers have been specifically trained for classroom instruction, is the difficulty of enacting approaches to teaching mathematics or creating math classroom learning environments with which teachers have little familiarity. Although there is wide agreement that mathematics teaching should change in the direction of reform, put simply, it is easier said than done. Some teachers did receive government-sponsored workshops, but these were often poorly designed and/or led by persons who themselves did not have a clear image of what reform instruction should look like or how to make it happen in the classroom. The MARAL project was designed to begin to deal with this challenge by engaging teachers in reform-oriented professional development activities that are grounded in their own practice (Smith, 2001).

Teacher development is of particular importance for school settings in Lebanon, because many teachers are now being asked to engage in practices that are unfamiliar to them, and they did not experience themselves as learners. Thus it was of great importance for the MARAL project to aim toward a close intertwining of research and teacher development.

The Design of the MARAL Project

MARAL was launched initially for one year (continuation subject to funding) to (a) study what is happening in elementary mathematics classrooms in Lebanon at the school level and (b) to use what is learned from looking inside classrooms to design forms of practice-based professional development. Site selection was a lengthy process that involved initial site visits to all schools expressing interest in the project, followed by a rigorous application process. All schools that applied were invited to at least participate in professional development. In all, approximately 40 schools participated in the professional development aspect of the project. However, lesson videotapes, observer field notes, and audio taped teacher interviews were systematically collected at a smaller sample of elementary classrooms representing both private schools and public schools in the Government system, and schools in which mathematics is primarily taught in English, as well as schools in which Arabic is the main language of math instruction. The sample consisted of 8 private and 5 public schools with approximately 55% instruction in English and 45% instruction in Arabic and with an approximately even distribution across grade levels one through six. All or nearly all teachers were observed at each school at least once per data collection cycle.

Because little research focusing on mathematics classroom instructional processes has been done in Lebanon, this work was relatively small in scope with the aim of providing foundational research methods and frameworks on which to build future mathematics classroom research in Lebanon. The aim was also to create a generative database.

Data were collected in the fall and spring which consisted of a combination of videotaped and non-videotaped lesson observations covering all or most teachers and grade levels at each school. In the fall, observations and interviews were conducted on two consecutive days, while in the spring all data collection at each site was completed in one day (additional data collection projects were conducted early in the fall outside the boundaries of the main data collection effort). During each data collection visit, teachers received individual feedback. School or program-level feedback was provided at a later time in the form of a written report and feedback meeting at each site. In addition, workshops for teachers, coordinators, and principals were provided throughout the school year. The data collection and development activities occurred as summarized in the following table:

Activity	**Date**
Orientation workshop all sites: What is high level thinking, reasoning, & communication	End of September
Special **data collection** projects	October
Workshop all sites: Adapting/changing low level tasks into high level tasks; classroom management	End of October
Intensive **data collection** at 13 sites; Individual immediate teacher feedback	November – early January
Program level feedback reports, dissemination of Nationwide level preliminary technical report	February - March
Workshop all sites: Nationwide report; fostering independent thinking; reacting to student errors/eliciting student thinking/open questioning	Early April
Intensive **data collection** at 12 sites (1 site boycotted all things American and dropped out); individual immediate teacher feedback	Late April – end of May
Program level feedback reports	June

An Example of Development Grounded in Practice

A preliminary pass through the fall data revealed a variety of findings related to the nature of the mathematical activities, discourse, and learning environments found in Lebanese elementary classrooms. Among the prominent findings across classrooms and schools were (a) that teachers were having

difficulty in having open interactions with students and eliciting student communication about their own thinking and (b) students were heavily dependent on the teacher for everything, including knowing what to say or write and when to say or write it. We chose to develop a workshop for teachers, coordinators, and principals aimed at addressing both of these issues as directly as possible. The workshop was conducted in a full day session beginning with a presentation about the nationwide technical report based on the aggregated data from the fall observations. During that presentation the two target problems mentioned above were emphasized as being pervasive across classrooms and schools. In general the participants recognized these two issues as problematic for them and seemed enthusiastic to focus on them for the remainder of the workshop.

Openness and Eliciting Student Thinking. We began this portion of the workshop by presenting research results on the nature of students' own questioning through primary, elementary and intermediate grades. The overall pattern presented was that as time goes on, students ask fewer and fewer genuine inquiry or "curiosity" questions, while there is an increase in the number procedural questions asked by students. We raised the following question for discussion by participants: "What is our role in this decline in genuine student inquiry over time?" We then presented a model of open vs. closed teacher behaviors and questioning and discussed the likely impact of each approach on students' inquiry and communication in the classroom. Following this discussion, we presented teachers with two real dialogue situations taken from Lebanese classrooms in which a teacher is responding to a student at the chalkboard. One of the dialogues we used is given below:

The following is a part of a real conversation between a student and a teacher that is closed. Your task is to rewrite the dialogue so that it becomes more open, meaningful and focused on making sense. Try to use questions like the open questions we discussed earlier. Be ready to act out your dialogue during the whole group discussion.

The class is practicing multiplication of two digit numbers. The students have a worksheet with several problems and they are discussing the exercise 32 x 47. The teacher called Fuad to the board to show and explain how he solved the problem. Here is Fuad's original work:

$$\begin{array}{r} {\scriptstyle 1}\\ 32\\ \times\ 47\\ \hline 284\\ 1280\\ \hline 1564 \end{array}$$ (other kids are calling out, it's wrong!)

Teacher: You have made a mistake Fuad. Can you find it?

Fuad: ***Silent, staring at his work*.**

Teacher: Let's go over your steps. First you multiplied the 7 times the 2 and got 14. You wrote the 4 and carried the 1, right?

Fuad: **Nods yes.**

Teacher: Then what did you do?

Fuad: **I multiplied.**

Teacher: Ok what should this number be? (points to the "28" in 284)

Fuad: **Silent.**

Teacher: You should multiply the 7 times the 3, right, and add the 1 to give you 22 here so it should be 224, not 284, right?

Fuad: **Silent.**

Teacher: So erase the 8 and put a 2. (Fuad erases the 8 and changes it to a 2.) Ok, now correct your sum. (Fuad corrects his final answer.) Bravo Fuad, 1504. Does everyone have 1504?

Class: **Yes! (many students shouting)**

Our aim was engage participants actively with using the research ideas presented to generate a different (and perhaps improved) image of this type of interaction between teachers and students and to gain a sense of the different potential impact of the two images on student learning and understanding in the classroom.

Fostering Independent Thinking. In order to focus participants' attention on the second issue that arose from our preliminary pass through the data, we engaged them in a mini-lesson in which a member of the MARAL team acted as the teacher and the participants took on the role of the students. At the end of the lesson, we facilitated a discussion among participants about the ways in which student independence was being fostered during the mini-

lesson they had just experienced. The lesson outline we used was the following: **Introduction to Division With or Without Remainders**

Learning Objectives:

- Students will be able to model division situations using counters.
- Students will be able to write number sentences to match their model.
- Students will be able to explain in writing what it means to divide.

Flow of Activities:

- [10 min]Teacher will demonstrate with help of students how to model a division situation (with counters + drawing + number sentence) for division into equal groups (with and without remainder).
- [20 min]Teacher will give each pair a sheet with two division situations to model with counters, draw a picture of the model, and write number sentences to match. Teacher walks around the room to monitor work and question students about their work.
- [5 min] Teacher asks pairs at the same table to compare/share answers and help each other if any corrections are needed.
- [10 min] Teacher asks students to think for 30 seconds quietly about what division means. NO talking, just thinking. Then teacher asks students to take turns explaining at their table what division means, each person can talk for 30 seconds (the teacher will tell students when to switch). Then teacher asks the students to think about what everyone said at the table and then to write in their copybooks what division means, they have to use examples (different from the ones used in class) and they should use pictures, words, and symbols to help them explain what they think division means.

Again, here we were aiming toward engaging participants as learners in a lesson approach that was very different from what they were used to in order to help them build a different image of the possible roles teachers and students could have in a mathematics lesson.

Summary

The dual purposes of the MARAL project are to conduct classroom-based research on Lebanese elementary mathematics teaching and learning and, at the same time, to support teachers in their efforts to engage students in high level thinking, reasoning, and communication. In the project we have tried to create a generative database and also to design development experiences that are grounded in research on the very practice that we are trying to develop. In this way, the project aims to be responsive to the real needs of teachers and to make the research seem as relevant to them as possible with respect to their own practice. There have been many indicators that this approach is promising and is having an impact on the practice of project participants and we are in the process of trying to systematically study this impact.

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