Cultivating Parent-Child Collaboration Concerning Mathematical Learning

Paper presented by: Dr. Regina Mistretta

Ms. Catherine Downey

St. John's University

The School of Education

718-390-4491

mistretr@stjohns.edu

Abstract

To address the critical need for teachers to guide parents on how to reflect classroom practices so that the goal of students succeeding in mathematics can be achieved, this paper reports on a study that investigated the extent Pre-K through 8th grade parents collaborate with their children on mathematical tasks. The study also involved an evaluation of a model mathematics initiative designed with conditions that sought to cultivate productive collaboration between parents and their children.

Findings reveal significant grade level differences in parent-child collaboration, specific parental needs that warrant attention, and favorable feedback to efforts designed to energize the home-school mathematics connection. Findings serve to empower the content of teacher education programs so that preservice and inservice teachers are knowledgeable of parental needs and sufficiently trained to nurture parent-child collaboration concerning mathematical learning.

Cultivating Parent-Child Collaboration Concerning Mathematical Learning

Introduction

Parents who are involved in children's learning of mathematics have a profound effect on one's ability to learn. Studies find that consistent parental involvement provides a strong foundation for children's attitudes towards mathematics (Kliman, 1999), promotes mathematics understanding (Kokoski & Downing Leffler, 1995) and produces higher academic achievement in mathematics (Goldstein & Campbell, 1991). Just through the simple act of children engaging in discussion with a parent about their mathematical thinking can improve their achievement (Ford & Crew, 1991; Epstein & Dauber, 1991; Myers, 1985). Unfortunately though for most parents the reform efforts affecting today's mathematics classrooms have created a much different learning environment than they experienced as young learners, and fear of the unknown often results in confusion and anxiety about how to help their children (Author, 2004).

This paper reports on a study that investigated the extent Pre-K through 8th grade parents collaborate with their children on mathematical tasks, and evaluated a model mathematics initiative designed with conditions that sought to cultivate productive collaboration between parents and their children. Findings reveal significant grade level differences in parent-child collaboration, specific parental needs that warrant attention, and favorable feedback to efforts designed to energize the home-school mathematics connection. References to parents and parental collaboration are meant to include all adults who play an active caretaker role in a child's home life.

Purpose

Knowledgeable of the value of parental collaboration, a former president of the National Council of Teachers of Mathematics stated that "we have to help parents bridge their fear and encourage them to join hands in providing a solid mathematics education for all students" (Price, 1996). Currently though the formal training of educators to nurture parental collaboration in any form is under-emphasized in the regiment of teacher education programs in the United States (Witmer, 2005). The National Center for Education Statistics (2003) reported that 48% of teachers indicated that their lack of adequate training for effectively involving parents was a significant barrier.

To address this critical need for teachers to be better prepared to guide parents on how to reflect classroom practices so that the goal of students succeeding in mathematics can be achieved (Bezuk, Whitehurst-Pane, & Aydelotte, 2000), answers to the following research questions were sought: 1. To what extent do parents collaborate with their children about mathematical learning and does this vary across grade level groups (Pre-K through 2, 3 through 5, and 6 through 8)? 2. What challenges do parents face collaborating with their children about mathematical learning and does this vary across grade level groups (Pre-K through 2, 3 through 5, and 6 through 8)? and 3. How effectively does a model mathematics initiative cultivate parent-child collaboration in grades Pre-K through 8?

Teacher preparation programs play a vital role in empowering teachers with the necessary skills to cultivate parent-child collaboration. This study serves to energize the content of teacher education programs with findings that highlight both parental needs and field-tested strategies towards nurturing such collaboration in the area of

mathematics education. These findings, when included in teacher preparation courses and professional development initiatives, add to the knowledge base and contribute to the sufficient training of preservice and inservice mathematics teachers.

Theoretical Framework

When the family is viewed as separate from the school, a message that the education of children is the sole responsibility of the schools is likely to form. To deliver a more accurate message about the importance of parent-child collaboration concerning academic learning, the theory of overlapping spheres of influence identifies students as the main actors in their education, supported by others at home, at school, and in their communities (Epstein, 1987). The combined efforts of these supporting factors benefit students, strengthen families, and improve schools.

Specific benefits of parental input have been noted in the area of mathematics education. For example, as parents become more involved, their understanding of the changes occurring in school mathematics increases, and they begin to support and enhance their school's efforts to reform mathematics programs (Peressini, 1997). Teachers benefit as well from families serving as an added resource that support learning beyond school hours (Sanders & Epstein, 1998), and parents realize the opportunities they have to interact with their children and do mathematics together (Moldavin, 2000).

Effective steps towards cultivating productive collaboration between parents and their children include parents participating in workshops that promote awareness of changes in mathematics education (Sheldon & Epstein, 2001). One such change is the use of manipulatives in the mathematics classroom. Survey results consistently indicate that parents frequently request hands-on workshops so they can concretely learn how to

use the tools their children are using in school (Author, 2004; Orman, 1993; Dauber & Epstein, 1993; Epstein, 1986).

Another important finding is that parents are much more knowledgeable about their children's learning of mathematics at the close of a series of activities where both parents and children engage in mathematical tasks together (Tregaskis, 1991). This form of collaboration, when extended to the home, can in turn reflect classroom learning of mathematics (Cathcart et al., 2003).

Research reveals the value of parental involvement and the importance of the manner in which educators establish collaboration between parents and their children. The study discussed in this paper adds to the existing research through efforts that sought to develop an understanding of how parents collaborate with their children, the challenges they face, and the effects of steps taken to cultivate productive collaboration in mathematics education.

Method

Participants

A population of 977 parents of Pre-K through 8th grade children from seven nonpublic schools in the metropolitan area of New York participated in the study. Their ethnic backgrounds consisted of 3% Asian, 53% African-American, 23% Caucasian, and 20% Hispanic. Funding requirements guided the selection process to target schools with families of low socioeconomic status and whose children were classified with low mathematics achievement levels based on standardized testing scores. The parents were categorized into three grade level groups, namely Group 1 (parents of children in grades Pre-K through 2), Group 2 (parents of children in grades 3 through 5), and Group 3

(parents of children in grades 6 though 8). Thirty-two percent (317) of the parents had children in grades Pre-K through 2, while 35% (339) had children in grades 3 through 5, and 33% (321) had children in grades 6 through 8.

Parent Initiative Model

The goal of the parent initiative was to energize learning at home with respect to mathematics education by exciting both parents and their children about doing mathematics together. It sought to inform, engage, promote reflection, and maintain collaboration between parents and children concerning mathematical learning. The initiative's model framework consisted of six components involving parents and children from grades Pre-K through 8. A mathematics professional development program was being implemented in the same schools by the same facilitator of the parent initiative allowing the content and instructional methods of the parent initiative to be consistent with that of the children's mathematics teachers. These teachers attended the parent initiative sessions to allow them to experience the dynamics of the parents and children working together. They also participated in maintaining the connection established by the initiative.

Beginning with the thought that if schools and students reach out and invite parents into a "village of learners," they will come (Guastello, 2004), along with the realization of the importance of creating an atmosphere of consideration and real partnership (DeLaCruz, 1999), an invitation to the parents was designed. This first component of the initiative informed parents of the initiative's intent, requested their commitment to participate, and inquired about times that would best suit their busy

schedules. To personalize the experience, students designed their own cover for their parents' invitation.

The second component of the initiative was an initial workshop attended by parents only. This component informed them about the importance of their involvement and the rationale behind specific instructional methods used in the mathematics classroom. Topics of discussion consisted of the changes in mathematics teaching through the decades, a constructivist foundation to teaching mathematics, the value of manipulatives (moveable objects) to make abstract concepts concrete, the importance of parental involvement, and productive ways parents can collaborate with their children to support mathematics education reform efforts.

The dynamics of the third component, an engagement workshop, depicted an active and insightful environment for parents and their children as they explored spatial relationships among tangram pieces (a seven piece set of shapes consisting of 2 big triangles, 1 medium triangle, 2 small triangles, a square, and a parallelogram), and reasoned about ways to solve a mathematics problem relevant to their grade level using tangrams (Adams, 1996). Emphasis was placed on communicating in both written and verbal form so that information and ideas could be gathered and organized, as well as thoughts clarified in a meaningful manner. Parents were advised not to do all of the telling. Rather they were encouraged to communicate and explore their children's thought processes by asking questions such as: Where shall we begin? What do we know that can help us? Can we approach this another way? Why? and How? This workshop concluded with a sharing of solutions in both small and large group settings.

To both reinforce and extend the engagement workshop experience, the fourth component of the initiative consisted of home activities distributed to the parents along with related content information to guide their solutions. These activities reflected those completed at the engagement workshop. Parents were instructed to collaborate with their children in the same manner they did during the engagement workshop. They were reminded to not do all of the telling, but rather to communicate and explore thought processes together. Most importantly, emphasis was placed on the importance of just having fun at home with mathematics!

The fifth component, a follow-up session, served to promote reflection as a learning community. Families came back to share solutions as well as contribute feedback to the following questions: 1. What was your solution and how did you arrive at it? 2. Did you and your child approach the problem in the same manner? 3. How did you help each other? 4. What did you find interesting about working with each other? and 5. Would you change anything the next time concerning your method of solution or how you worked together?

To ensure continuity of the strides made thus far, the sixth and final component of the initiative concerned mechanisms to maintain the collaboration between parents and their children. An interactive homework assignment, classroom follow-up techniques, and an interactive newsletter served to maintain the established home school mathematics connection. The interactive homework assignment required parents and their children to use tangrams once again. The format of the assignment consisted of sections where the parents were invited to work with their child on a mathematics task relevant to their grade level (Adams, 1996), gave necessary background information, facilitated a cooperative

effort between the child and their parent, promoted a sense of multiple methods of solution, and provided parents with the opportunity to give feedback about the assignment.

To maximize the potential of the interactive homework assignment and foster classroom communication among students about learning at home with their parents, the teachers of the students involved in this study allotted classroom time for the students to share their interactive homework assignments with each other and offer feedback. Students discussed how their solutions were similar and how they were different, as well as the most enjoyable and the most challenging aspects of collaborating with their parents. Such discussion reinforced the students' conceptual understandings and skills with the assignment's task, and allowed them to interact as a community of learners who are growing with their parents as partners in their learning of mathematics.

The interactive newsletter served to review the initiative's components. Explanations of what was done at each stage of the initiative were given along with a website corner containing internet resources involving tangrams, a book corner containing children's literature that incorporate tangrams, and a listing of additional resources concerning the use of tangrams and mathematics in general. A report on classroom events related to the initiative and an area for parents to share their comments were included as well.

Measures

Parent Survey

A parent survey (see Appendix) consisting of 14 statements requiring 5-point Likert scale responses and one narrative response question was utilized in this study to

investigate the extent of parents' collaboration with their children's learning of mathematics. The statements inquired about actions such as helping with mathematics homework, preparing for mathematics tests, communicating about what is being learned in mathematics class, discussing different ways to solve mathematics problems, communicating with the mathematics teacher about their child's progress, and voicing their concerns. The narrative response question asked the parents to highlight the challenges they face while helping their children with mathematics.

Parent Evaluation Form

An evaluation form consisting of four statements requiring 5-point Likert scale responses and three narrative response questions was utilized to assess parents' reactions to the initiative. Parents responded with extremely well, very well, adequately well, not very well, or not at all to the following statements: 1. This initiative increased my awareness of the need for parental collaboration in mathematical learning, 2. This initiative increased my awareness of current forms of mathematics instruction, 3. This initiative increased my awareness of the use of tangrams in mathematical learning, and 4. This initiative increased my awareness of the importance of communication about mathematical thinking. In their narrative responses, parents shared how the home activities were most helpful, what surprising and/or interesting events occurred at home, and how the entire experience impacted on the family.

Student Reflection Form

A reflection form consisting of two narrative response items was utilized to assess students' reactions to the initiative. In their responses, students shared the most enjoyable and challenging parts of working with their parent. In cases in grades Pre-K

through 2 where communication in written form posed a challenge, students were asked to either speak about or draw a picture that depicted their response.

Procedure

The parent survey was administered by the investigator of this study to parents at each of the participating schools. An independent samples t- test was completed to compare the overall mean responses among the three groups of parents. Mean responses to each individual statement were compared within and among the parent groups to note the specific ways parents involve themselves in their children's learning of mathematics. Narrative responses to the question concerning parental challenges were tallied and transformed into percentages to determine the existence of patterns within and among the parent groups.

The rationale for and design of the parent initiative model implemented during this study stemmed from the theory of overlapping spheres of influence, supporting research on parental involvement, best practices advocated by the National Council of Teachers of Mathematics (NCTM, 2000), and the identified needs of the parent population who participated in the study as evidenced from the results of the previously described survey.

After reviewing invitation responses for the most convenient times for the parents to participate, the initiative was facilitated by the investigator of this study with groups of approximately 50 parents and children at a time (from grades Pre-K through 8) at each of the participating schools. Approximately 85% of the parent population at each school participated in the initiative. The rationale for involving such a wide span of grade levels was to build parents' awareness of the incremental power of manipulatives throughout

the grades and diminish the possible misunderstanding that manipulatives exist only for use by younger students. Engagement workshops were held two weeks after the initial workshops, and follow-up sessions were held two weeks after the engagement workshops.

Parent evaluations and student reflection forms were completed at the close of the follow-up session. On-going evaluation on the part of the investigator of this study was conducted through group discussions with teachers at each school to monitor the implementation of the interactive homework assignment, classroom follow-up techniques, and the interactive newsletter. At these discussions, teachers shared classroom experiences concerning the progress of these strategies to maintain the home-school mathematics connection, and reported on parent feedback gathered from the comment sheets included with the interactive homework assignment and newsletter.

Results

Parent Survey

A reliability analysis was done to determine the reliability of the parent survey. The obtained overall alpha level was .919, indicating high reliability since the alpha level was greater than 0.8. The alpha levels for Groups 1, 2, and 3 were .905, .888, and .921 respectively, indicating high reliability as well within each group of parents.

Independent samples t-test data (see Tables 1 and 2) concerning the overall mean responses between Groups 1 and 2 (3.9906 and 3.8234), and Groups 2 and 3 (3.8234 and 3.3048) revealed significant declines ($p<.01$) in parental collaboration as grade levels increased. Comparisons of mean responses for each survey statement (see Table 3) among each group surfaced the highest mean for Groups 1 and 2 (4.75 and 4.47,

respectively) for survey statement 4, and the highest mean for Group 3 (4.12) for statement 12. The lowest mean for all groups (2.96, 2.84, and 2.63, respectively) was for statement 14.

Of the 977 parents who completed the first portion of the survey consisting of the 14 statements, 287 parents completed the portion requiring a narrative response. Noted patterns indicated that the most reported challenge (23% of those responding) especially among parents of Groups 2 and 3, was that "math is taught differently than in my time." This finding should be viewed with caution though, since not all of the parents responded to this portion of the survey. However, this response is consistent with the findings of a previously conducted study (Author, 2004) where the majority of a population of 790 parents of children in grades Pre-k through 8 noted this same concern.

Parent Evaluation Form

The responses to the four statements on the parent evaluation form revealed the majority of all three parent groups responding with either extremely well or very well to statements 1(90%, 93%, and 88%, respectively), 2 (89%, 93%, and 89%, respectively), 3 (90%, 93%, and 88%, respectively), and 4(95%, 100%, and 90%). Positive feedback was gleaned from all narrative responses concerning the home activities. The most frequently noted feedback among all three parent groups (75%, 83%, and 77%, respectively) concerned their appreciation for the opportunity to work together with their child and share ideas.

Student Reflection Form

Positive feedback was gleaned from all student reflection forms about their collaboration with their parents. The most frequently noted feedback (80% of the

students) concerning the best part of working with their parents was their opportunity to share a method of solution that was different from that of the parent. The most frequently noted challenge (82% of the students) was that the parents wouldn't offer the answers but questioned how and why.

Discussion

Parent Survey

Overall mean responses to the parent survey revealed regular levels of collaborative efforts between parents and children of Grades Pre-K through 2 and Grades 3 through 5 concerning mathematical learning, but only a moderate level of collaboration between parents and children of Grades 6 through 8. Further analysis showed that even though collaboration was common among Grades Pre-k through 2 and Grades 3 through 5, parents and children in Grades 3 through 5 were collaborating significantly less than parents and children in Grades Pre-k through 2. This decline in collaborative efforts surfaced again when overall mean responses highlighted parents and children in Grades 6 through 8 collaborating significantly less than parents and children in Grades 3 through 5.

Review of mean responses to the individual survey statements indicated that the most common form of collaboration existing between parents and children of Grades Pre-k through 2 and Grades 3 through 5 was parents checking to see if homework was finished with less attention paid to checking whether the homework was correct or not. The most common form of collaboration existing between parents and children in Grades 6 through 8 was parents providing a quiet setting for homework completion with even less attention paid than in Grades Pre-k through 2 and Grades 3 through 5 to checking whether the homework was correct or not. The least common form of collaboration

existing between parents and children of all groups was parents talking with their child's math teacher about their concerns.

This last finding may be due to the limited amount of time parents and children spend working together on mathematical tasks as revealed from the parent survey. Survey findings showed parents taking on a role that engages them for the most part in checking that the home allows for assignment completion, and less involvement in sharing ideas about mathematical thinking. Greater emphasis by teachers on parents' role as learning partners may energize parents' interest in voicing their concerns and learning about ways they can better collaborate with their children.

Narrative survey responses depicted parents' feeling disconnected from current mathematics instruction. Common responses included "Math is taught differently than in my time. I don't want to confuse my child", "I don't know how to use manipulatives," and "I need answers to my child's questions about how mathematics applies to the real world." Such cries from parents need to be heard by teachers so that they can properly service needs, encourage more communication about concerns, and ultimately enrich students' learning experiences.

Parent Evaluations and Student Reflections

Positive parent and student feedback to the initiative was gleaned from the parent evaluation and student reflection forms. Parents indicated being more aware of the need for parental collaboration in mathematical learning, more knowledgeable of current forms of mathematics instruction including the use of manipulatives (specifically tangrams), and better prepared to communicate with their child about mathematical thinking. Narrative responses included "This initiative allowed me to see how my child's mind

works," "Now I listen and guide rather than insist on using my way to solve a problem," and "The communication that this initiative fostered among the entire learning community helped demystify mathematics."

Students reported that working with their parents was enjoyable for reasons such as "I got to share my ideas with my mom and she shared hers with me," We put our thinking together and got a chance to brainstorm," and "I'm happy now because when I go home my parent will know what I'm talking about." Students also reported the experience as challenging for reasons such as "My parent didn't give me the answer," "I had to do a lot of the thinking and explain my answers," and "Looking for different ways to solve the problem made my head hurt."

Conclusions and Recommendations

This study reveals the need for meaningful and consistent parental collaboration in mathematics education in Grades Pre-k through 8, and describes action steps that can effectively cultivate such collaboration. Survey findings shed light on the need for educators to encourage parents to assume tasks that go beyond just checking homework and providing a quiet environment in which to work. Parent and student reactions to the described mathematics initiative surfaced a sense of active engagement in mathematical learning as opposed to being on opposite sides of the fence.

Responsibility for the goal of empowering parents lies in great part with teacher preparation programs. Inclusion of this paper's findings into preservice and inservice mathematics methods courses as well as professional development programs can energize today's training so that teachers are better prepared to service parental needs and nurture productive collaboration between parents and children. Future research should expand

upon this study's investigation by involving other academic areas. Deepened understanding of parental needs and effective action steps towards cultivating parent-child collaboration allows teacher educators to make informed decisions about teacher education programs and professional development initiatives that will ultimately improve student achievement.

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Table 1		
Independent Samples t-test Results for Groups 1 and 2		
Group	***M (SD)***	***p***
1 (*n = 317)* 2 (*n* =339)	3.9906 (.75) 3.8234 (.75)	.004

Table 2		
Independent Samples t-test Results for Groups 2 and 3		
Group	***M (SD)***	***p***
2 (*n* =339) 3 (*n = 321)*	3.8234 (.75) 3.3048 (.95)	.000

Table 3
Mean Responses to Survey Statements

Group	***S1***	***S2***	***S3***	***S4***	***S5***	***S6***	***S7***	***S8***	***S9***	***S10***	***S11***	***S12***	***S13***	***S14***
1	3.97 (*316)*	4.28 *(315)*	3.90 *(292)*	4.75 *(314)*	4.68 *(311)*	3.86 *(310)*	3.89 *(307)*	4.41 *(313)*	3.83 *(287)*	3.94 *(308)*	3.76 *(309)*	4.35 *(307)*	3.01 *(296)*	2.96 *(293)*
2	3.59 (*337)*	4.26 (*339)*	3.87 (*337)*	4.47 (*338)*	4.20 (*339)*	3.85 (*336)*	3.82 (*337)*	3.97 (*339)*	3.49 (*332)*	3.84 (*337)*	3.92 (*329)*	4.33 (*331)*	2.98 (*325)*	2.84 (*322)*
3	2.91 (*318)*	3.97 (*320)*	3.10 (*320)*	3.90 (*321)*	3.32 (*320)*	3.22 (*319)*	3.19 (*321)*	3.21 (*321)*	3.08 (*317)*	3.27 (319)	3.45 (*314)*	4.12 (*314)*	2.83 (*315)*	2.63 (*310)*

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Appendix

Parent Survey

After each statement, circle the number in each row that corresponds to your response.

1 almost never 2 seldom 3 about 50% of the time 4 usually 5 almost always

1. I help my child with math.
   1 2 3 4 5
2. I ask my child what he/she is doing in math.
   1 2 3 4 5
3. I help my child prepare for math tests.
   1 2 3 4 5
4. I check to see if my child is finished with his/her math homework.
   1 2 3 4 5
5. I check to see if my child's math homework is correct.
   1 2 3 4 5
6. I ask my child to explain to me how they arrive at their math solutions.
   1 2 3 4 5
7. I talk with my child about different ways to solve a math problem.
   1 2 3 4 5
8. I help my child correct their mistakes on math homework.
   1 2 3 4 5

9 I help my child correct their mistakes on math tests.
   1 2 3 4 5

10. I share ideas and talk with my child about math homework/projects.
    1 2 3 4 5
11. I point out to my child how math is used in our everyday life.
    1 2 3 4 5
12. I provide a quiet setting for my child to do math homework.
    1 2 3 4 5
13. I ask my child's math teacher about his/her progress in math.
    1 2 3 4 5
14. I talk with my child's math teacher about my concerns about mathematical learning.
    1 2 3 4 5
15. **Please respond to the following question in depth. Give specific examples where appropriate.**
    What challenges do you face helping your child with mathematics?