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Start at Square One

Which Way Will You Effect Change in Our Profession?

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Purpose Statement

The purpose of the National Journal of Mathematics Education Leadership is to advance the mission and vision of the National Council of Supervisors of Mathematics by:

- Strengthening mathematics education leadership through the dissemination of knowledge related to research, issues, trends, programs, policy, and practice in mathematics education

- Fostering inquiry into key challenges of mathematics education leadership

- Raising awareness about key challenges of mathematics education leadership, in order to influence research, programs, policy, and practice

- Engaging the attention and support of other education stakeholders, and business and government, in order to broaden as well as strengthen mathematics education leadership

A Local Systemic Change Project in Mathematics Professional Development for Improving Student Achievement in Low-Performing Districts in Maine

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Broadening Educational Access to Mathematics in Maine (BEAMM) was a K-8 mathematics curriculum implementation project funded by the National Science Foundation (NSF) as a Local Systemic Change project. The BEAMM project involved seven low performing Maine districts with 500 teachers and 13,000 students, the Maine Mathematics and Science Alliance (MMSA)— a non profit organization, and two mathematics faculties from Colby College. The thrust of BEAMM was to have teachers and building administrators participate in various professional development experiences to improve student learning in mathematics.

The goal of BEAMM was to increase student performance in mathematics by providing professional development and support for the implementation of high quality curriculum materials for all K-8 teachers of mathematics in the seven school districts. These districts had not met the AYP targets in grades 4 and 8 for three years or more. They were asked to commit to participate in BEAMM.

Given the goal of BEAMM, the professional development needed to focus on improving student performance, the implementation of new curriculum materials, reaching all the teachers, and providing them with substantial learning experiences. The outcomes required teachers to:

- Utilize and build their mathematics knowledge and skills through professional development.
- Understand mathematical ideas and pedagogy for long-term student learning and achievement.
- Create student-centered classrooms by using exemplary instruction, curriculum materials, and assessment practices.
- Reflect on their practices and participate in collegial discussions about teaching and learning.
- Work and communicate with their K-8 colleagues in the partner districts and beyond.

As none of the districts had the same mathematics curriculum across all of their schools, the first task was for each of the districts to choose an elementary program and middle level program from a prescreened list of NSF funded standard-based programs. This selection process resulted in a choice of three elementary programs and two middle level programs across the seven BEAMM districts.

Professional Development Model

BEAMM's professional development model was originally comprised of three parts. These included 1) support for all teachers with activities such as 2 week summer institutes, one and two day events, and on site support by teacher leaders; 2) professional development for teacher leaders which included an additional one week summer institute and curriculum developer/publisher training in specific curriculum materials; 3) assistance for administrators in the partner districts including Advisory Board involvement, one day events at institutes, and training in supervision and observation techniques. This approach was based on the assumption that all of the teachers would participate in at least one of the three parts in the design.

After the initial curriculum program summer training, project staff and district leaders were faced with the reality of the teachers' background, district disposition for and support of teachers, and teachers' personal commitment or interest in learning mathematics. These factors combined made for

demands that were more complex than the "neat" three part model could adequately address. The initial professional development approach was more of a traditional static, undifferentiated model with teachers attending structured sessions delivered by primarily mathematics leaders. Several additional factors also influenced how we thought about the delivery of the professional development. There was a significant level of mobility, about 30% of teachers and 82% of building principals over the period of the project. New teachers included those who were new to teaching, those who were experienced but new to the curriculum, and those who were experienced but had not taught math consistently were being added to the districts' mathematics teaching staff. At the same time, the existing teachers were learning more about their new curriculum and were beginning to ask more targeted and relevant questions. The progression from a "beginner" to "user" to "expert" varied much more than had been expected. Consideration of this mixed audience was a strong influence in designing additional opportunities for district level professional development involving all teachers of mathematics.

The professional development model was adapted in an attempt to provide support in the context of these dynamic realities. The plan became more comprehensive, more responsive, and less centralized. A new framework, adapted from *Concerns-Based Adoption Model* (CBAM) (Hall and Hords, 2001), defined the type of professional development needed by various audiences. The framework included three stages: Level I, Beginning Stage of Implementation; Level II, Implementation with Reflection; and Level III, Implementation with Refinement.

A description of each of the professional development levels follows.

Level I: Beginning Stage of Implementation: Training/support at this level was for teachers new to the profession, content, the curriculum program, or to the grade level. A majority of BEAMM sites provided this level of support for new hires within the district through participation at regional sessions or mentoring by teacher leaders. These sessions were offered though the entire life of the project rather than just in the first year as previously planned.

Level II: Implementing with Reflection: Teachers at this level were typically in the first few years of using the district's chosen curriculum program. Their professional development focused on issues of early implementation such as choosing a management system for grading/assessing, tracing a content strand through the grades, and becoming experienced with the instructional activities. Many topics discussed at initial trainings were revisited later in deeper conversations. Professional development at this level focused on how the curriculum materials are being implemented in each classroom. Important topics at this stage include pacing, content coherence, instructional techniques, use of technology, student grouping, changes in assessment strategies, and looking at student work. An Everyday Math Assessment Series, specific curriculum sessions, and district level activities such as bi-monthly grade level meetings facilitated by teacher leaders or BEAMM project staff are all examples of professional development activities for Level II educators. These types of sessions developed into regular ongoing activities within and outside of the districts.

Level III: Implementing with Refinement: Teachers at this level had been implementing a specific program for several years, had participated in a variety of professional development activities at the initial and reflection stages, and were very comfortable with the instructional philosophy, mathematical content, and assessment features of their program. The professional development focused on refinement of content knowledge and teaching processes. Activities included institutionalizing assessment, online book studies, researching and discussing best practice, conducting peer observations, examining student work to identify evidence of understanding, and planning instructional activities to extend and enhance content knowledge beyond the parameters of the program. Although many of the Level II sessions also focused on assessment, Level III reflected deeper levels of discussion, content, and connection to instructional practices. These types of professional development support were provided cross-district or on district request. Table 1 shows some examples of the activities within this plan for differentiated professional development.

Leadership Strategies

To sustain the efforts and to reach all teachers, even those who were the reluctant learners, BEAMM strove to build the content and curricular leadership of teachers. Strong embedded leadership was a critical factor for a variety of reasons including: sustaining the vision of mathematics learning and teaching, maintaining continuity despite teacher and administrator mobility, and developing ongoing support structures such as study groups. Continuous improvement required leadership at three levels: central administration, building administration and teacher leaders.

Teacher Leader strategy. On-site teacher leaders represented a key to sustaining the momentum of the reform efforts. These teachers were self-selected or were nominated by their districts and by the BEAMM Advisory Group. The teacher leaders committed

Table 1: Examples of Supported Professional Development by Implementation Level

Level I Beginning Implementation	Level II Implementation with Reflection	Level III Implementation with Refinement
Mathematics problem solving K-8	User groups in a Math curriculum	Mathematics sessions for specific grade spans
Curriculum Showcases	Assessment series specific to programs	Special populations focus for specific mathematics programs
Curriculum orientation and structures	Content focused sessions	Users support and enhancement for implemented units
		Formative Assessment Strategies using cognitive research

to attending Advisory Board meetings and summer leadership institutes, hosting and organizing school or district professional development, and attending monthly BEAMM district meetings with the site-contact. The support for the teacher leaders enabled them to: recognize quality professional development, develop a repertoire of techniques for conducting professional development, connect the techniques to multiple and specific curriculum programs, and gain additional mathematics content and pedagogy. University faculty, national experts and project staff provided training and support to the teacher leaders. Some examples include: examining and assessing student ideas, classroom observation, algebra across the grades, mathematical learning paths, professional development strategies (Loucks-Horsley, Love, Stiles, Mundry & Hewson. 2003), facilitating adult learning and the change process with the CBAM.

The blend of mathematics content and adult learning strategies was very helpful to leaders as they became discouraged with the slow pace change by their colleagues. The content provided the basis for their confidence in mathematics, and the adult learning strategies provided a context for them to be patient and to stay focused on guiding the process and not get frustrated. It was enlightening for them to realize that there was a body of literature and set of strategies to help them work with their peers and that working with their peers was different than working with their students. At the end of BEAMM, thirty-two teacher leaders had exceeded 100 hours of PD. This represents about 6% of the total BEAMM teacher population of 500, or about 1 teacher leader for every 16 teachers.

Administrator strategy: The BEAMM project recognized the importance of administrator support for mathematics education. Hence each participating district was asked to build its own internal capacity to carry out professional development activities during and after the project ended by: providing cross grade face-to-face meetings for teachers; implementing exemplary mathematics curriculum materials; creating and maintaining K-12 mathematics committees; releasing teachers for 5 days during the year to work on BEAMM activities; fostering study groups during the year; and participating in electronic web-based professional development forums.

To accomplish these objectives each partner district convened a leadership team with at least one administrator to guide and assess progress, to represent their site on the BEAMM Project Advisory Board and to help the district team write and revise a yearly professional development plan with an evaluation component. At each Advisory Board session, team members gave updates, evaluated impact of professional development on classroom instruction, and planned or refined next steps. The project provided a variety of opportunities to keep administrators informed and connected. The Advisory Board also recommended specific supports for administrators such as curriculum trainings, one-day workshops with teacher leaders, and Lenses on Learning training (Miles-Grant, Scott Nelson, Davidson, Sassi, Shulman-Weinberg, & Bleiman, 2003). Administrators took an active role in the development and implementation of these plans.

Analysis

The question that needs to be answered for BEAMM is: *Did the BEAMM professional development and implementation of high quality curriculum materials help improve 4th and*

8th grade students' mathematics performance? Several analyses were conducted to attempt to determine the impact of the BEAMM project on student learning. The first was a comparison of the state Maine Educational Assessment (MEA) scores between the BEAMM districts and Comparison Districts, the second was an effect size score analysis, and the third was a student cohort comparison over the period of the project.

The MEA data was collected for the BEAMM sites and Comparison Districts as it was the only common large scale assessment used by all the districts. The BEAMM districts were located across the state, ranging in size from 3 schools to 9 schools serving about 13,000 students. Each BEAMM district was matched with a comparison district based on their socioeconomic status, similar geography and school size, grade spans (K-6, 6-8 and K-8), and similar student performance. Not much is known about the professional development or the mathematics curriculum used in the Comparisons Districts.

The MEA is administered every year to all grades 4, 8 and 11 students in the state. The MEA is a standardized criterion reference exam with 40% multiple choice and 60% constructed response items. It is aligned to the state's standards as each mathematics question is written based on a performance indicator in the state's Learning Results. The MEA produces two types of student performance data, both scaled scores for students and schools and performance level assignments for students that are aggregated to percentages for schools and districts. All the 4th and 8th grade students in each of the districts are included in the assessment data. Over 98% of Maine students in grades 4 and 8 take the MEA with a special waiver required for exceptions.
Students' scores in the BEAMM districts were compared to their own prior performance, to Comparison Districts, and to the state average scores. The categorical student performance data from the MEA's - *Does Not Meet Standards, Partially Meets Standards, Meets Standards,* and *Exceeds Standards* - was analyzed using a proportional statistics technique to quantitatively determine the amount of movement of students in the different performance levels reported by the MEA.

The analysis employed the standard error for proportion differences in the performance levels to the <.05 level. The formula for this analysis is: $\sqrt{((C/T) \times (1-C/T)/T)} = G$ where C represents the number of students in category, T is the total of students and G is the proportional difference between student performance levels categories. To a >.05 level $(G \times 1.96) \times 100 = se$ where se is the standard error. This analysis determines if the change in numbers of students scoring in a particular performance level was significant as compared to what might occur with normal variation due to population changes.

Results

For the BEAMM District and Comparison Districts MEA comparisons, two of the four student performance levels were used, *Meets Standards* and *Does Not Meets Standards*. The two other levels, *Exceeds Standards* and *Partially Meets Standards* do not reflect the areas of emphasis for the project. The percentage of BEAMM students performing at the Meets Standards level on Maine's 4th and 8th Grade MEA increased and the percent at Does Not Meet the Standard category decreased (Table 2).

At the 4th grade level, the percent of students in the BEAMM sites meeting the standards increased from 15% in 1999 to 24% in 2004, a 60% change. The percent of students not meeting the standards decreased from 35% in 1999 to 23% in 2004, a 34% change. At the 8th grade level, the percent of students in the BEAMM sites meeting the standards increased from 15% in 1999 to 20% in 2004, a 33% change. The percent of students not meeting the standards decreased from 42% in 1999 to 33% in 2004, a 20% change.

At the same time the Comparison Districts and the State average score also reported increases in the number of students in the *Meets Standards* category and decreases in the *Does Not Meet Standards* category. The BEAMM districts reported a higher percentage gain than both the State and the Comparison Districts (with the exception of grade 4 *Meet Standards* in the comparison schools).

A second set of results from an effect size analyses showed whether the changes were significant. Over the course of the five years, the districts' average 4th grade scaled scores on the MEA improved from 527 to 536 (9 points) while the state average improved from 531 to 536 (5 points). The Comparison Schools improved from 530 to 535 (5 points) similar to the statewide average. The mean score gain between 1998 -1999, the year before BEAMM began, and 2004 -2005, the year after it ended was 7.14 across the BEAMM sites with a standard deviation of 2.54. The average gain across the comparison schools was 5.43 with a standard deviation of 3.46. The BEAMM schools showed greater improvement and the variation among the sites was less than that among the Comparison Districts. The effect size of the BEAMM Initiative is .52 or a moderate or large difference for an effect size difference (Coe, 2000. Cohen,1998).

In addition an analysis was made to determine whether the same cohort of students' performance was static, sustained or grew over four years of the BEAMM project. Test results for two cohorts of students over a span of four years starting in grade 4 and then four years later in grade 8 were compared. For both cohorts of students there were increases in the percentage of students in the *Meets Standards* and decreases in the *Does Not Meet Standards* performance levels. At the same time, the state average scores reported decreases or no change for the same two cohorts of students in the *Meets Standards* performance level and increases in the *Does Not Meet Standards* performance levels. See Tables 3 and 4.

These results indicate that the students in the BEAMM Districts demonstrated increases in their performance over the course of the project. Their rate of change illustrates that BEAMM had greater increases in numbers of students moving into the Meets Standards performance level, and had larger decreases in numbers of students moving out of the Does Not Meet Standards performance level than the state average. Because there was some student movement in and out of the districts over the course of four years, this comparison is not a precise measurement. Nevertheless, the number of students in each cohort is approximately 1600 so the variation due to student mobility is minimized.

Conclusion

A number of features of BEAMM seem to have contributed to the better than expected improvements, but to the project staff the adjustments to the professional development model was key. BEAMM provided ongoing offerings that included levels of complexity and depth depending on the expertise and needs of the teachers and was able to reach teachers who initially would not attend events at their schools. There was professional development for administrators and teacher leaders creating a district level team to help sustain the ideas and momentum of the efforts at the local level with the teacher leaders helping to lead and focus the district/school based professional development. BEAMM's professional development maintained coherence by focusing on the targeted mathematics and on program implementation issues. Significantly, however, the activities offered a range of complexity for the content and skills to parallel teachers' developmental needs.

Differentiating professional development to support practicing teachers is a goal of most professional development. Although it is difficult to deliver tailored experiences with large numbers of teachers, doing so addresses the important connection between the dynamic wants and needs within a district. Everyone in the BEAMM

Table 2: Student Performance for 1999 and 2004 for BEAMM and Comparison Districts.

	1998-1999 Percent			2003-2004 Percent			DIFFERENCE in percent '98-'99 to '03-'04		
FOURTH GRADE	**BEAMM**	**Comparison Districts**	**State**	**BEAMM**	**Comparison Districts**	**State**	**BEAMM**	**Comparison Districts**	**State**
Meets Standards	15	22	22	24	32	30	+9	+10*	+8
Does Not Meet Standards	35	29	27	23	20	20	-12	-9	-3
EIGHTH GRADE	**BEAMM**	**Comparison Districts**	**State**	**BEAMM**	**Comparison Districts**	**State**	**BEAMM**	**Comparison Districts**	**State**
Meets Standards	15	14	21	20	15	21	+5**	+1	0
Does Not Meet Standards	42	44	37	33	39	32	-9***	-5	-5

* The Comparison Districts were statistically higher than the BEAMM districts for *Meets Standards* category; however the BEAMM Districts closed the size of the gap that originally existed.
** The BEAMM sites were statistically different from the Comparison Districts in increasing the number of students in *Meets Standards*.
*** The BEAMM sites were statistically different from the Comparison Districts in decreasing the number of students in the category of *Does not Meet Standards*.

Districts, from central office administrators to new classroom teachers contributed to and learned from the BEAMM project. In addition to the range of needs among educators across a district, the high mobility in and out of districts represented a challenge to improvement efforts. Situations in which few, if any, in leadership positions remained in a district over the course of the project - to carry the vision and maintain momentum - struck BEAMM project staff as a significant threat to reform. Addressing these dynamic aspects of the educational system, the continuum of teachers' professional needs and educator mobility, is critical for ensuring successful professional development and for sustaining reform efforts.

BEAMM is not the first project to identify the idea of differentiated professional development, but its importance needs to be reiterated because of the current context of educational reform with high expectations for rapid change. Gamoran (2005) among others proposes that schools can best support teaching for understanding by responding to teacher learning (Mundry, 2005; Gamoran, et al. 2003). The factors in BEAMM that contributed to the improvement for low performing districts seem to include consistent, coherent and differentiated professional development that meets the various needs of teachers, involvement and support for administrators at the building level, principals, and central office levels, knowledge and skill building of talented teacher leaders, and having high expectation for all teachers and students through a high quality curriculum. The authors believe that differentiation of professional development is critical to addressing the many aspects of the educational system to support the range of roles within districts.

Table 3: Cohort 1 BEAMM and State Percentages for Two Cohorts of Students for Four Years

	1998-1999		2002-2003		CHANGE	
Performance Level	**BEAMM 4th**	**State**	**BEAMM 8th**	**State**	**% Change in BEAMM**	**% Change in State**
Exceeds Standards	0.00%	1%	1.00%	1%	+ 100%	0
Meets Standards	14.42%	22%	20.00%	17%	+ 38.6%	- 22.7%
Partially Meets Standards	50.10%	50%	50.00%	50%	- .2 %	0
Does Not Meet Standards	35.27%	27%	30.00%	32%	- 14.9%	+ 18.5%

Table 4: Cohort 2 BEAMM and State Percentages for Two Cohorts of Students for Four Years

	1999-2000		2003-2004		CHANGE	
Performance Level	**BEAMM 4th**	**State**	**BEAMM 8th**	**State**	**% Change in BEAMM**	**% Change in State**
Exceeds Standards	1%	2%	1%	1%	0	- 50%
Meets Standards	16%	21%	20%	21%	+ 25%	0
Partially Meets Standards	46%	48%	46%	46%	0	- 4.1%
Does Not Meet Standards	37%	29%	33%	32%	- 10.8%	+ 34.4%

References

Coe, R. (2000). "What is an Effect Size" CEM Centre, Durham University.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). New Jersey: Lawrence Erlbaum.

Hall, Gene E. & Hord, Shirley M. (2001). *Implementing change: patterns, principles, and potholes.* Boston: Allyn and Bacon.

Gamoran, A. (2005). Organizational capacity for change. (Romberg, Carpenter & Dremock. Editors) in *Understanding mathematics and science matters*. Matwah, NJ: Lawrence Erlbaum Associates, Publishers.

Gamoran, A., Anderson,C., Quiroz, P, Secada, W., Williams, T. & Ashman,W. (2003) *Transforming teaching in math and science: How schools and districts can support change*. New York: Teachers College Press.

Loucks-Horsley, S., Love, N., Stiles, K., Mundry, S., & Hewson, P. (2003). *Designing Professional Development for Teachers of Science and Mathematics*. Thousand Oaks, CA. Corwin Press.

Miles Grant, C., Scott Nelson, B., Davidson, E., Sassi, A., Shulman Weinberg, A., Bleiman, J. (2003) *Lenses on Learning: A New Focus on Mathematics and School Leadership.* Lebanon, IN: Pearson Learning Group.

Minium, Clarke, and Coladarci, (1999) *Elements of Statistical Reasoning*. New York, NY: John Wiley and Sons.

Mundry, S. (2005) Changing perspectives in professional development. *Science Educator*. National Association Science Education Leadership Association. 14(1), 9-15.